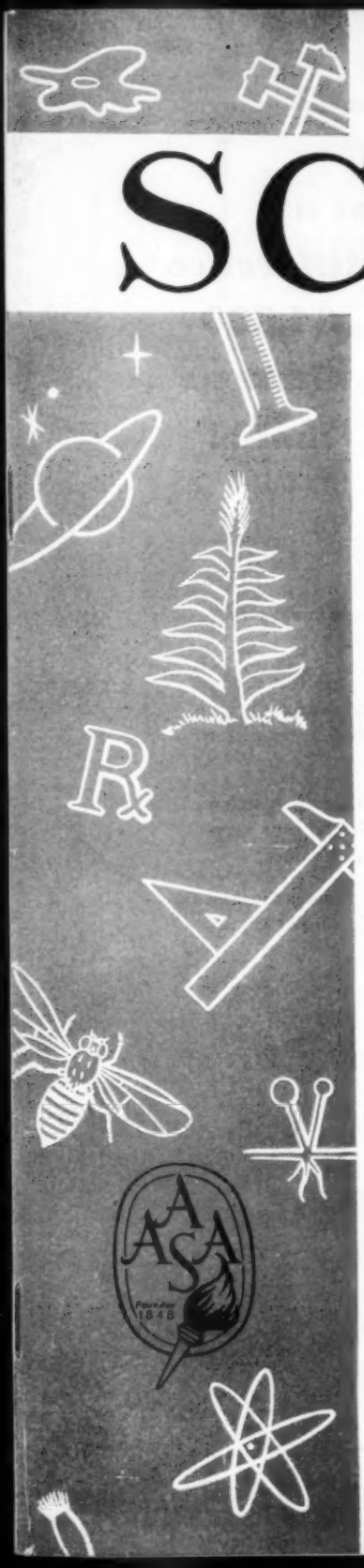

# SCIENCE

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## Contents



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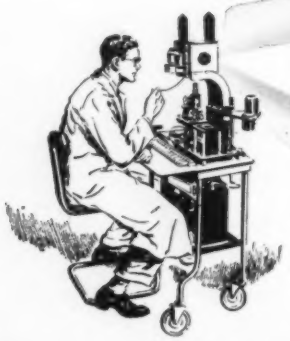

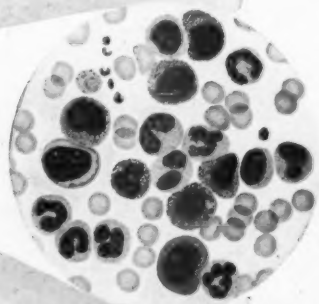

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# TRAVEL ARRANGEMENTS FOR THE AAAS BERKELEY MEETING

## December 26-31, 1954

In time or in cost, a trip from an eastern city to California is not much more than a **round trip** to a midwestern city. Californians who for years have been attending meetings in the East have told their colleagues that the continental distance is the **same** each way, and that it should be the turn of the Easterners to visit the Pacific Coast.

The Association is planning ways it may assist those who will attend the 121st AAAS Meeting on the campus of the University of California at Berkeley, this December. The possibilities include:

1. Low cost AAAS limousines from Oakland and San Francisco airports and railroad terminals direct to the dormitory or hotel of each delegate.
2. Arrangements for traveling together in AAAS cars on fast trains leaving Chicago, Washington, D. C., and New York.
3. Arrangements for chartering first class DC6, 6B, or 7 planes of scheduled airlines—at prices comparable with air coach travel.

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| Air coach (no meals) | $167.20 | $215.69 | $217.80 |
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# Armed Forces Institute of Pathology

THE transfer of the Armed Forces Institute of Pathology in early autumn to its new home on the grounds of Walter Reed Army Medical Center marks the end of an era and the beginning of a new one. The Army Medical Museum, from which today's Armed Forces Institute of Pathology has evolved, was founded in 1862 as a center for medical officers seeking information on diseases of military importance. As modern pathology developed, its function gradually changed, until in World War I it became the central laboratory, in World War II, the Army Institute of Pathology. To fill the needs of a greatly augmented Army, the personnel was multiplied. The professional staff was supported by a visiting staff of leaders in pathology. Publications from the Institute are evidence of the research on medico-military problems that flourished despite the great volume of diagnostic work. In this period the pattern of the organization was set, and its three chief functions—consultation, training, and research—were defined. With inclusion of service to the Veterans Administration, and again with unification of the Armed Forces, its responsibilities were enlarged, and now the Armed Forces Institute of Pathology is the central laboratory of pathology for Army, Navy, and Air Force and provides consultation service to the Veterans Administration and Public Health Service.

During this period of expansion, civilian participation in its activities became increasingly significant. Although the bulk of material comes from the Services, about 10,000 cases are contributed annually by civilian physicians to the American Registry of Pathology, one of its departments. Composed of 22 registries of special pathology, sponsored by 17 national medical associations, it functions in cooperation with National Research Council. Intensive research on a specific disease or the pathology of particular anatomic regions is conducted in each registry, headed by the chief of the corresponding section in the Department of Pathology.

The consultation service furnished the Armed Services insures rapid and expert pathologic diagnosis wherever our soldiers, sailors, and airmen are stationed. It is accomplished by expeditious handling within the AFIP, aided by modern air transportation and communication. Microscopic slides and records, identified by a number for each case, become part of the permanent collection; material acquired subsequently and autopsy specimens in event of death are added to the numbered unit file.

Interesting specimens are displayed in the Medical Museum, which is open to the public and attracts many visitors. The chief mission of the Museum is education, but research is served by the collection it maintains for investigative studies.

Another department that performs public service is the Medical Illustration Service. It maintains an extensive loan library of medical films for the Services and civilian medical groups. From its print collection, many authors select illustrations for medical articles. Development of visual aids for teaching medical sciences and preparation of exhibits for national and international meetings are other educational functions.

With the conveniences of a larger, modern building, the best in laboratory equipment, an enthusiastic professional staff, supported by expert technical, clerical, and other workers, the future of the Institute should be increasingly productive. Laboratories for tissue culture, cytophysics, histochemistry, radiobiology, microbiology, and other special techniques that extend the horizons of pathology, will provide enlarged opportunities for postgraduate training and permit more scientists to carry on research.

Research has been dominant at the AFIP, and the names of Woodward, Reed, Callendar, Lucké, Ash, and Wilder recall some of its significant contributions. Its traditions encourage industry, assure freedom in research, and support the principle that administration exists to aid scientific progress. Under the management of the Surgeon General of the Army, with the Surgeons General of the three services composing the board of governors, a Department of Defense directive assures a true academic environment for the future. The staff now can investigate the physico-chemical machinery of the cell as well as its form, and the intricate processes through which various agents affect that machinery. Although the scope of research will be broadened, its purpose will remain constant: to improve, by study of causes and effects of disease, the health of our fighting men and the people they defend.

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*Brigadier General, Medical Corps, U.S. Army*

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# The Inflorescences of Maize

O. T. Bonnett

*Department of Agronomy, University of Illinois, Urbana*

SINCE the discovery of maize, in 1492, by two explorers sent out by Columbus, the morphological peculiarities of the ear and tassel of maize have been of special interest to some and of general interest to all who are acquainted with the maize plant. Early descriptions and drawings of the maize plant gave attention to the inflorescences. Lyte's description [*New Herbal*, 1619], quoted by Arber (*1*), Mangelsdorf and Reeves (*2*), and Mangelsdorf (*3*), of the inflorescences of maize is vivid and picturesque.

> This corne is a marvelous strange plante. . . . Nothing resembling any other kind of grayne; for it bringeth forth his seede cleane contrarie from the place whereas the flowers grow, which is agaynst the nature and kindes of all other plants, which bring forth there fruit there, whereas they have borne their flower . . . at the highest of the stalks grow idel and barren eares, which bring forth nothing but flowers or blossome. . . . The fruitful ears do grow, upon the sides of the stems amongst the leaves, which ears be great and thick, and covered with many leaves so that one cannot see the ears. . . . The grayne or seed which groweth in the ears, is about the quantitie or bignesse of a Pease, of colour in the outside, sometimes browne, sometimes redde, and sometimes white, and in the inside it is in colour white, and in taste sweet, growing orderly about the eares, in nine or ten ranges or rows.

This is a good description of the major characteristics of the ear and tassel even by present standards.

The main purpose of this paper (*4*) is to consider, from several aspects, the inflorescences of normal dent maize, especially of the ear, which is annually the source of billions of bushels of food and feed. However, it was the morphological differences between the ear and the tassel and, also, the unique characteristics of the maize inflorescences in contrast with the inflorescences of other cereal grasses that impressed the first observers. The unique characteristics of the maize ear and tassel continue to be of great interest to all who work with the maize plant. From a practical standpoint, the capacity of the maize plant to produce seed is affected by certain morphological characteristics of the ear and by certain intraplant relationships among the ear, the tassel, and other parts of the plant. Therefore, to provide a botanical basis for understanding this great food plant, the morphological features that characterize it and distinguish it from other cereal grasses are described as clearly as possible within the limited space available here. In addition, the chemical composition of the maize kernel and its modification by selection are discussed briefly. Finally, an attempt is made to show why the maize plant is superior as a producer of cereal grain.

## The Mature Maize Plant

At maturity the above ground parts of a maize plant consist of the stem, foliage leaves, tassel, and ear (Fig. 1). The stem is divided into nodes and internodes, which are of varying lengths. The foliage leaves are in two ranks, one at each node, and they alternate

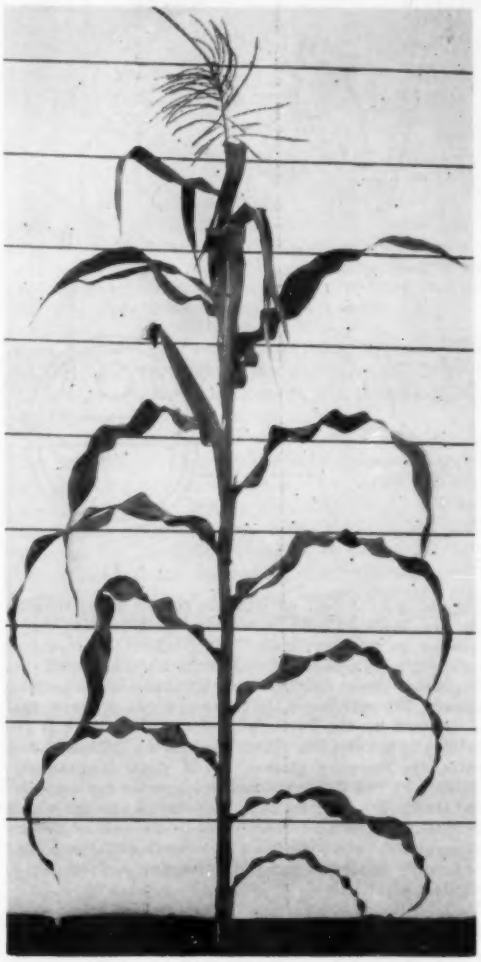

Fig. 1. A maize plant showing the alternate, two-ranked arrangement on the main stem, the tassel, terminal on the main stem, and the lateral axillary branch on which the ear develops.

on the stem. The tassel, which produces only pollen, terminates the stem. A lateral axillary branch (or branches), in the upper portion of the plant, is terminated by the ear, which produces only seed. The lateral ear-bearing branches have short internodes, and they have modified leaves (husks) whose arrangement on the branch is the same as on the main stem.

Since maize is a grass, the unit of the inflorescence is a spikelet (Fig. 2). In maize the spikelets are in pairs. A spikelet is a condensed branch consisting of a short stem, the rachilla, upon which are placed two leaflike structures, the sterile glumes, so named because they do not bear flowers in their axils (Fig. 2*A–D*, *g*). In the tassel the sterile glumes completely enclose the flowers, but in the ear they only partly enclose the flowers (Fig. 2*C*, *g*). Two flowers are produced in each spikelet.

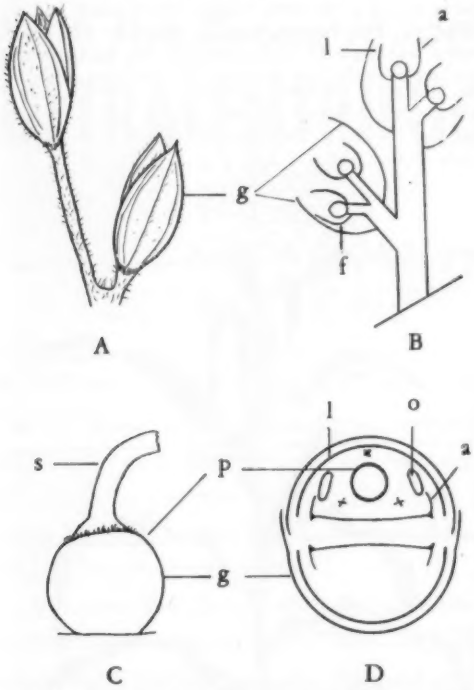


Fig. 2. (*A*) A pair of spikelets from a tassel showing the pedicellate spikelet on the long stalk and the sessile spikelet on the short stalk. (*B*) Diagram of a pair of spikelets from a tassel. A spikelet is a short branch that originates from another branch, the spikelet-forming branch. The spikelet is the portion of the diagram that is enclosed by the sterile glumes and the flower is the portion of the diagram that is enclosed by the lemma and palea, the flowering glumes. (*C*) A pistil from an ear, enclosed by two sterile glumes, which in the ear are short and thick. (*D*) Diagram of a cross section through a pair of spikelets from an ear. Only one of the pair of flowers in the spikelet of an ear has a functional pistil. [*a*, palea; *f*, flower; *g*, sterile glumes; *l*, lemma; *o*, lodicule; *p*, pistil; *s*, style (silk)].

In the tassel both flowers of a spikelet produce stamen, but in the ear only one flower of a spikelet produces a pistil. Each flower has a pair of glumes, the lemma and the palea, called the flowering glumes (Fig. 2*B* and *D*, *l* and *a*). In the tassel the flower is enclosed by its glumes, but in the ear the flower is only partly enclosed by its glumes.

The major characteristics of the maize tassel and ear are shown in Figs. 3 and 4. Several of the many ways in which the ear and tassel differ from each other are listed in Table 1. This table also shows that the ear and tassel are alike in two respects. First, both have paired spikelets; and second, the ear and central axis of the tassel are symmetrical structures with the spikelets arranged upon them in many rows. In addition to these characteristics, the ear and tassel show a number of correlations in development (*5*, *6*), a list of which is given in Table 2.

## Inflorescences of Maize and Other Grasses Compared

The ear and tassel of maize are morphologically unique. The combination of a symmetrical, many-rowed central axis with asymmetrical, two-ranked basal branches found in the tassel does not exist among other grasses. Asymmetrical, two-ranked branches are found in the terminal inflorescences of *Euchlaena* (teosinte) and *Tripsacum*, two close relatives of maize, and in *Chloris* (finger grass), *Eleusine* (goose grass), and *Paspalum*. The symmetrical, many-rowed characteristics of the ear and the central axis of the tassel are also found in the inflorescences of

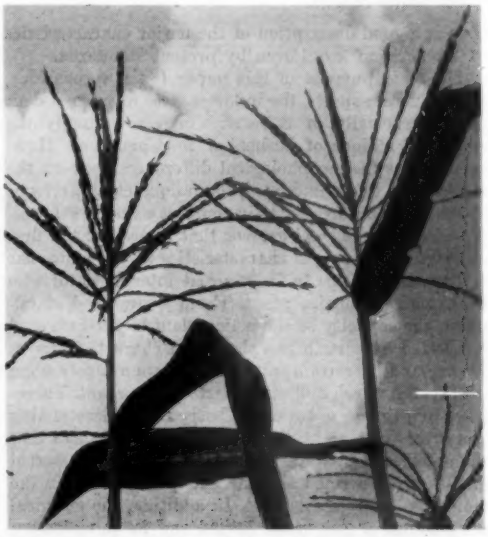

Fig. 3. Maize tassels which are terminal, staminate inflorescences having a symmetrical, polystichous central axis and asymmetrical, distichous lateral branches.

*Pennisetum glaucum* (pearl millet) and *Setaria lutescens* (yellow bristle grass). The paired spikelets of maize are found in *Tripsacum, Euchlaena,* and in the many members of the tribe *Andropogoneae,* to which sorghum and sugar cane belong. The characteristic of maize that distinguishes it from other grasses is the presence of two spikelets in the ear, each with a terminal, fertile flower and a lateral, aborted flower. A terminal, staminate inflorescence and a lateral, pistillate inflorescence, as found in maize, are found in only one other grass, *Euchlaena,* a close relative of maize (*7*). Other cereal grasses, including wheat, oats, barley, rye, rice, millet, and sorghum have inflorescences containing perfect flowers.

### Development of the Maize Plant

There are four major stages in the development of the maize plant, terminating with the mature seed. They are the vegetative, the transitional, the reproductive, and the seed stages. In each of these stages, the developmental activities are different (*6, 8, 9*).

In the vegetative stage, the tip of the main stem remains short (Fig. 5*A*); there is no internode elongation; and leaf primordia arise one above the other in alternate succession at a certain distance from the tip of the stem. Axillary branches are produced, and leaves arise from their tips in the same order as those of the main stem (Fig. 5*C*).

The transitional stage is of short duration and consists of an elongation of the tip of the stem (Fig. 5*B*), with no apparent differentiation of lateral organs. The transitional stage occurs in the main stem which gives rise to the tassel and in the lateral branch which gives rise to the ear.

Table 1. Differences between the ear and tassel.

| Characteristics | Ear | Tassel |
|---|---|---|
| *General* | | |
| Position on the plant | Lateral | Terminal |
| Long, basal asymmetrical branches | Absent | Present |
| Sex | Pistillate | Staminate |
| Fertile flowers per spikelet | One | Two |
| Sterile glumes | Short-thick | Long-thin |
| Flowering glumes | Short-thin | Long-thin |
| *Central axis only* | | |
| Sclerenchyma zone | Present | Absent |
| Rachis flaps | Present | Absent |
| Longitudinal grooves between spikelet rows | Present | Absent |
| Alveole | Present | Absent |

The reproductive stage begins with the initiation of branch primordia at the base of the elongated, transitional stem tip (Fig. 5*D, E*). At the same time that branch primordia are forming in the tip of the stem, the basal internodes of the main stem begin to elongate (Fig. 5*C*). Elongation of the internodes of the stem proceeds from the base toward the tip of the stem. Elongation of the main stem increases the height of the plant, resulting in the emergence of the tassel from the leaves that envelop it, and terminates with the maturity of the tassel.

Fig. 4. Part of the main stem and ear with the leaves and husks removed. This photograph shows clearly that the maize ear is a symmetrical, polystichous structure borne on a condensed, lateral, axillary shoot.

Branch primordia and their subtending ridges are the first lateral parts of the inflorescence to appear on the elongated tip of the stem of either the main stem or the lateral branch (Fig. 5*D, E*). In the tassel the branch primordia are of two kinds: those at the base of the tassel that elongate to become the long branches, and the spikelet-forming branches on the central axis and on the long branches of the tassel (Fig. 5*E, F*). All branch primordia of the ear are spikelet-forming branches (Fig. 5*D, E*).

In both the tassel and the ear, the spikelet-forming branches divide into two spikelet initials (Fig. 6*A, B, E*). One spikelet initial terminates the spikelet-

Table 2. Correlations in the development of the ear and tassel.

| Tassel | Ear |
|---|---|
| Internode condensation | Increased row number |
| Extreme condensation of central axis | Short blunt ears |
| Biparted and triparted central axis | Branchlike divisions of the ear tip |
| Two or many rows of branches and spikelets, central axis | Two or many rows of spikelets in ear |
| Tassel branch length | Ear length |
| Branch length pattern | Ear shape |
| Tertiary branches | Irregular rowing |

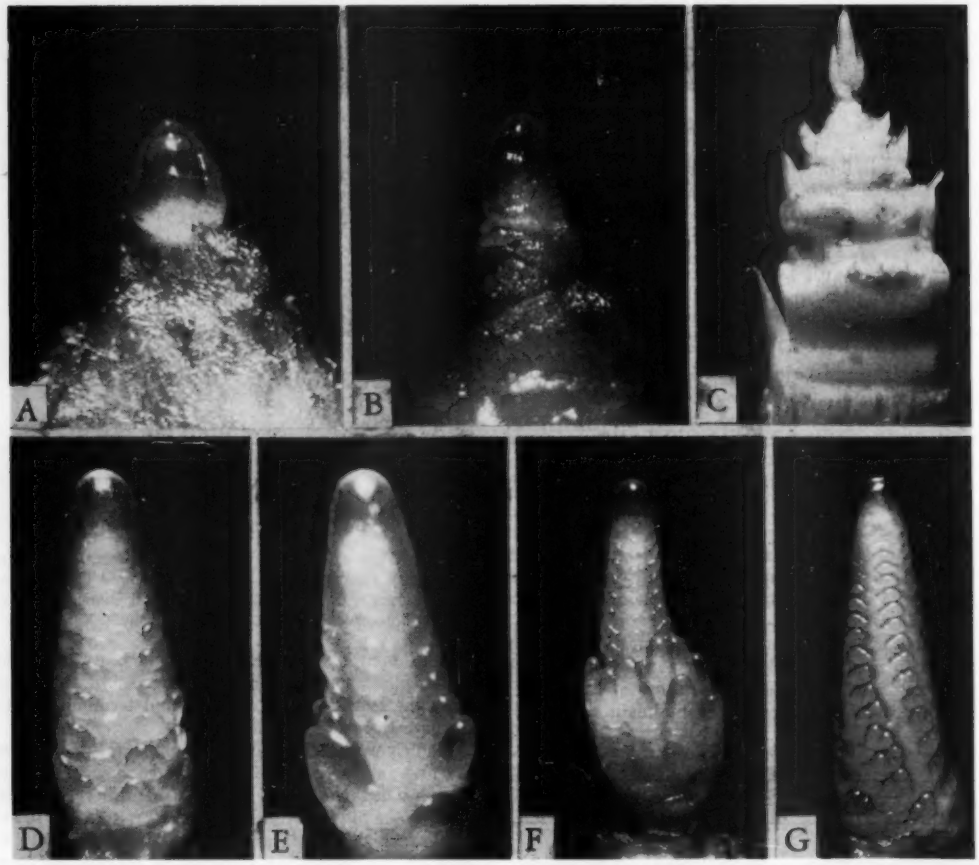


Fig. 5. External appearance of shoots of maize in the vegetative, transitional, and floral stages. (*A*) Main shoot in the vegetative stage having four leaves visible. Leaf primordia partly enclose the shoot apex (×44). (*B*) Main shoot in the transition stage, elongating, preceding the initiation of primordia of spikelet-forming branches (×35). [Photo by E. R. Leng, University of Illinois.] (*C*) Main stem with foliage leaves removed to show the tassel and the lateral axillary shoots (×7). (*D*) Ear shoot, showing spikelet-forming branches as protuberances, subtended by ridges (×49). (*E*) Early stage in the development of the tassel, showing long branch primordia at the base and spikelet-forming branches toward the apex (×44). (*F*) Spikelet-forming branches can be seen on the central axis and on the lateral margins of the long branches of the tassel primordium (×22). (*G*) Part of the spikelet-forming branches at the base of the ear primordium have divided into two spikelet initials (×22).

forming branch, and a stalk develops beneath it, producing the pedicellate spikelet (Fig. 2*A, B*). The other spikelet initial is a lateral branch, and since no stalk, or only a short stalk, develops beneath it, this spikelet is called the sessile spikelet (Fig. 2*A, B*). It is easier to distinguish the pedicellate from the sessile spikelet in the tassel than it is in the ear where both spikelets appear to be sessile. The pedicellate (terminal) spikelet is always ahead of the sessile (lateral) spikelet in development.

Two flowers are produced in each spikelet, a terminal and a lateral flower (Figs. 6*C, D* and 2*B*). In the tassel both flowers are functional, each containing three anthers and an aborted pistil (Fig. 6*G, J*). In dent maize, almost without exception, only the terminal flower of the spikelet of the ear develops (Figs. 6*F* and 2*D*). Pistils form in the functional flowers of the ear, but the stamens abort (Fig. 6*H*). Thus, the tassel functions as a staminate, and the ear functions as a pistillate inflorescence.

Development of the maize kernel begins with the fertilization of the egg and endosperm nuclei, within 26 to 28 hr after pollination (Fig. 6*I*). The endosperm nucleus begins to divide immediately after fertilization, but the first division in the fertilized egg does not occur until 10 to 12 hr later. Twenty days

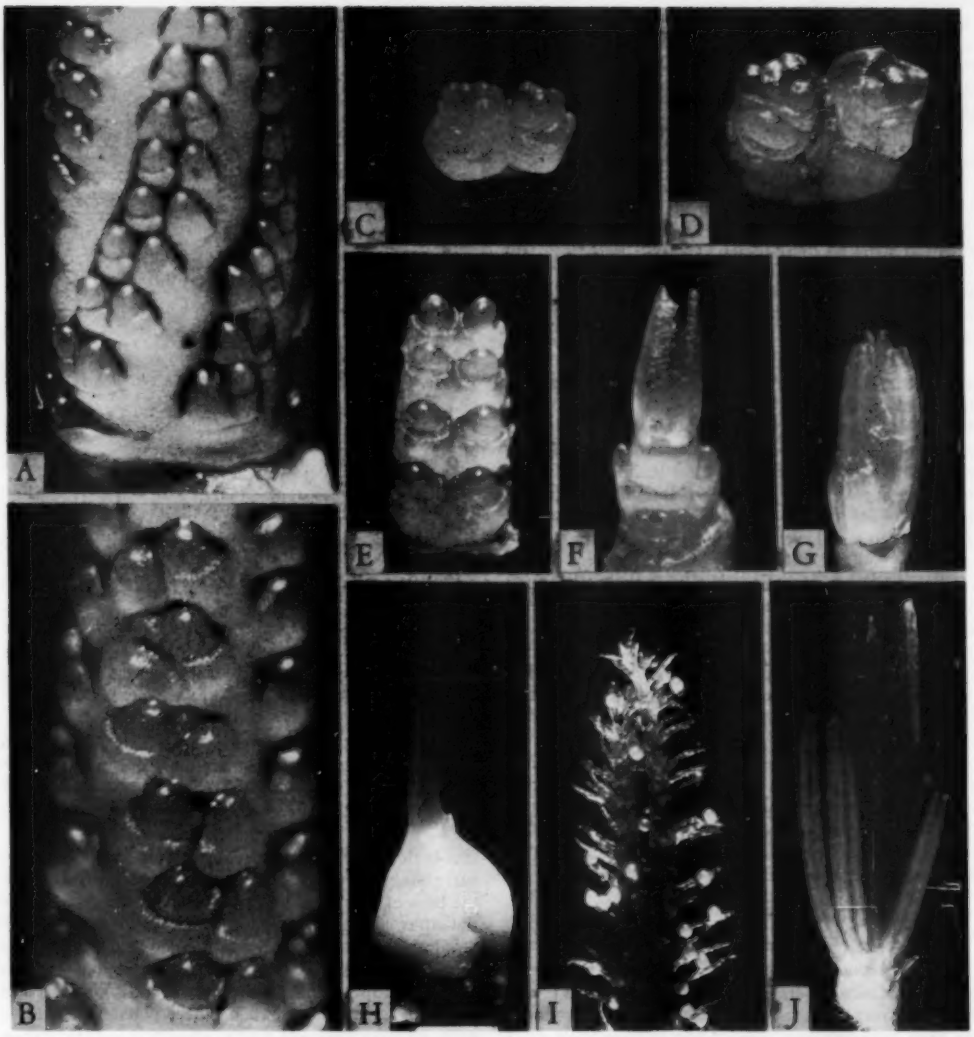


Fig. 6. Various stages in the development of spikelets and flowers of the tassel and ear. (*A*) A section of the base of an ear primordium showing the pedicellate (terminal) spikelet primordia with transverse ridges, glume initials, and the sessile (lateral) spikelet primordia without glume initials (×43). (*B*) Section of the central axis of the tassel, showing stages in the development of spikelet primordia comparable to *A* (×69). (*C*) Pair of pistillate spikelets, terminal and lateral flowers are differentiating (×47). (*D*) Pair of staminate spikelets, flowers as in *C* (×47). (*E*) Paired pistillate spikelets on a dissected portion of an ear (×43). (*F*) A pistillate spikelet, showing a terminal, fertile and a lateral, aborted flower. The silk on the fertile flower has a biparted tip (×34). (*G*) Staminate spikelet, outer glumes removed, showing the stamens of the two flowers enclosed by the thin flowering glumes (×9). (*H*) A pistil and portion of the silk (×17). (*I*) Biparted tip of a silk (style) showing pollen grains germinating on the stigmatic branches (×24). (*J*) A staminate spikelet, outer glumes and lemmas removed, to show the two functional flowers with stamens but no pistils (×9).

after pollination 89 percent of the seeds will germinate, but the percentage of strong seedlings is low (*10*). About 45 days after pollination the maize kernel reaches full maturity.

The maturity of the maize kernel marks the end of the last stage of development, and the maize plant begins to die. The maize kernel contains a young plant with a root and a shoot with four to five leaf initials,

enclosed by the coleoptile. The endosperm and germ contain a supply of nutrients, available to the young embryo when germination begins. The pericarp and seed coat enclose and protect the tiny living plant and its food supply.

Initiation of floral development begins first in the tassel and slightly later in the lateral shoot that develops into the ear. Although the tassel begins its development first, the ear shoot develops rapidly enough so that the silks emerge shortly after the first pollen is shed. In most maize varieties, the tassel matures its pollen in advance of silk emergence, but plant breeders select against any marked tendency toward a lack of synchronization in pollen shedding and silk emergence.

The morphological differences between the ear and tassel of maize do not result from any fundamental difference in the kinds of parts that arise from the shoot apices from which they are derived. The lateral organs of each of the inflorescences consist of shoots and shootlike parts and leaves and leaflike parts. The shoots or shootlike parts are the lateral branches of the first order (the long branches of the tassel and spikelet-forming branches), spikelets, flowers, stamens, and lodicules, each of which is initiated in the parent axis by periclinal cell divisions in the third cell layer of the shoot apex. The leaf and leaflike parts are the foliage leaves, prophylls, glumes, lemmas, paleas, carpels, and integuments, whose primordia are initiated by periclinal divisions in the first and second cell layers of the shoot apex. The basic difference between the ear and the tassel is that in the tassel some of the lateral branches at its base elongate and develop into long, unilateral, distichous branches, while in the ear the basal branches do not elongate but are spikelet-forming branches from the beginning. The developmental pattern of the basal lateral branches in each of the two inflorescences is one of the essential morphological differences between them.

### Functional and Developmental Relationships in the Ear and Tassel

Normally the tassel functions in maize only as a pollen producer. It has been estimated (*1, 11*) that there are from 9000 to 25,000 pollen grains produced for each silk produced by an ear. Kiesselbach (*11*) states that it has been calculated that an average tassel of the variety Nebraska White Prize would produce 25 million pollen grains. The period of pollen shedding varies in length, but it is, on the average, about 10 days. The length of the pollen-shedding period and the amount of pollen shed usually insure the fertilization of each functional pistil on an ear. Although many pollen grains may fall upon a silk, germinate, and send pollen tubes down the silk toward the embryo sac, only one pollen tube enters the embryo sac to provide the two sperms necessary for fertilization.

Ears develop from one or more of the upper axillary shoots of the stem (Figs. 5*C* and 7). The shoots formed at the base of the stem may remain nonfunctional or develop into tillers (suckers). Axilliary shoots develop in acropetal succession, and during the early stage of plant development they are largest at the base of the plant and progressively smaller toward the apex (Fig. 5*C*). Later, when the ears begin to develop, the size sequence changes, so that the topmost shoot is the largest, and the shoots become smaller from the top to the base of the plant. The topmost shoot or the topmost two or three shoots, depending upon whether they are single- or multiple-eared types, in turn take precedence in their development. The axillary shoots above and those below the one that becomes the ear (or ears) are inhibited by their development. The axillary shoots above the ear shoot (or shoots) are so inhibited that they cannot be seen except at very early stages in the development of the plant. What determines which axillary shoot or shoots will develop into ears is not definitely known, but it is correlated with tassel initiation. When tassel initiation begins, the last-formed axillary shoot (or shoots) too far advanced in development to be inhibited at tassel initiation becomes the ear shoot (or shoots).

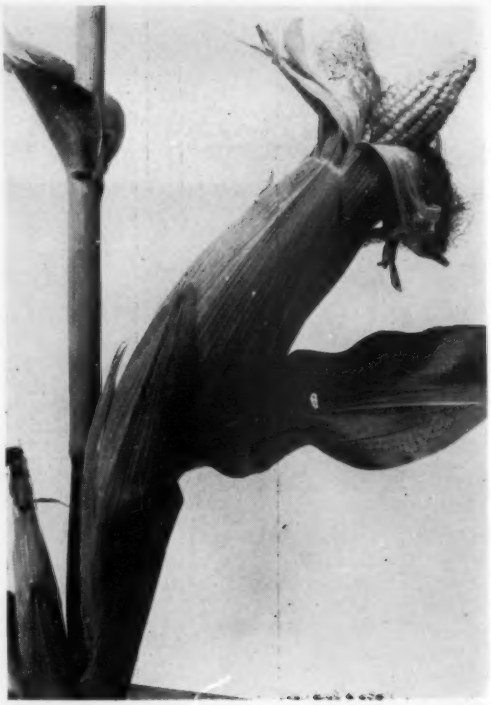

Fig. 7. A portion of the main stem and two lateral branches with the husks pulled back at the tip of the larger branch to expose the tip of the ear. Husks are modified leaves consisting of the leaf sheath either without a leaf blade or with a reduced leaf blade.

Developmental patterns of the topmost ear shoots in single- and multiple-eared types show interesting contrasts. Freeman (*12*) showed that, at an early stage

of development, the five topmost shoot primordia of a single-eared type had a large top shoot and, successively toward the base of the plant, four much smaller shoots, indicating a dominance of the topmost ear shoot. In multiple-eared types, the size of the ear shoots graded downward in size from the topmost shoot, indicating no dominance among the shoots.

Some interesting relationships in the development of ear shoots on single- and multiple-eared types have been shown by Lyons (*13*). He studied one-, two-, and three-eared maize types. If the topmost ear shoot was covered to prevent pollination, the number of normal ears produced in the one-eared type was none; in the two-eared type, one; and in the three-eared type, two. If two top shoots were covered, the two-eared type produced no normal ears, and the three-eared type, one ear. When the topmost shoots that normally produce the ears on two- and three-eared types were covered, lower shoots on a few plants produced ears varying from a few seeds to medium-sized ears. However, most plants failed to produce seed on the lower shoots, even though silks were exposed. Removal of the topmost one or two shoots of the one-eared type shifted the ear production to the next lower remaining shoot or shoots. In the two-eared type, removal of the topmost one, two, or three shoots shifted ear production to the next lower pair of shoots. In the three-eared type, removal of the two top shoots shifted ear production lower on the plant to the third, fourth, and fifth shoots. It would appear from these studies that a certain ear type will produce only a definite number of ears. Ear shoots, even though unfertilized, inhibit normal ear development in the next lower ear shoots, but when ear shoots are removed in certain combinations, development of ears on other shoots lower on the plant can take place.

The number of ears per plant is an inherited characteristic that can be affected by selection. Selection for two ears per plant was begun in on open-pollinated field of a normally one-eared, yellow dent corn at the Illinois Agricultural Experiment Station in 1905 and continued through 1927. Each year ears from plants having two ears per plant were selected, and the seed was mixed together to provide seed for the next crop. The percentage of two-eared plants increased from 6.7 percent to 80.1 percent in 1927. The percentage of two-eared plants varied from year to year, but after 1920 it was never below 48 percent.

Selection for height of ear was begun at the Illinois Agricultural Experiment Station in 1903 and was discontinued in 1928. High- and low-ear strains were established by selecting, from a field of open-pollinated yellow dent maize (Leaming), ears from plants that had their ears highest or lowest on the plant (*14*). At the beginning of the experiment, the ear height of the high-ear strain averaged 56.4 in. from the ground, and that of the low-ear strain averaged 42.8 in. from the ground. The greatest difference in ear height was obtained in 1927, 1 yr before the experiment was discontinued, when the average ear height of the high-ear strain was 120.5 in. from the ground, and that of the low-ear strain was 8.1 in. from the ground, a difference of 112.4 in. The greater ear height of the high-ear strain resulted from more and longer internodes below the ear, whereas the low-ear strain had fewer and shorter internodes below the ear, but the height of the plants from ear to tassel was the same in both strains.

The high-ear strain was 10 to 14 days later than the low-ear strain. The yield of both strains was less than normal corn. While the high-ear strain, owing to its extreme height, leaned badly or fell to the ground, the low-ear strain had a stiff erect plant. Owing to its short, stiff, erect stalk, the low-ear strain was used to produce stiff-stalked inbred lines, one or two of which have been used in the production of commercial hybrids. The high-ear strain has been of no value as a source of breeding material in the production of commercial hybrids.

### Ear Size and Factors Affecting It

The maize ear is a large inflorescence (Fig. 4). A good commercial hybrid grown at a planting rate of four plants per hill (16,000 plants per acre) will have from 750 to 800 kernels per ear, or a seed yield of 225 to 250 g per ear. Eight hundred kernels per ear is equivalent to 14 average oat panicles containing 60 kernels per panicle or 20 average wheat heads containing 40 kernels per head. One ear of maize producing 250 g of grain is equivalent to the weight of grain produced in 300 average-sized oat panicles or 200 average-sized wheat heads. The marked superiority of the maize ear as a seed producer lies not so much in the number of kernels per ear as in the weight of the kernel, which results in a high total weight of seed per ear.

The number of kernels per ear is determined by the number of rows of kernels (Fig. 8) and the number of kernels per row (Fig. 9). An ear having 800 kernels would require an 18-rowed ear with 45 kernels per row. Kernel-row-number has been found to vary from four rows in a distichous type to 30 or more

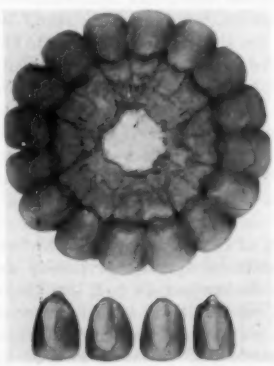

Fig. 8. Four maize kernels and a cross section of a maize ear demonstrating the many-kernel-row characteristics of the ear.

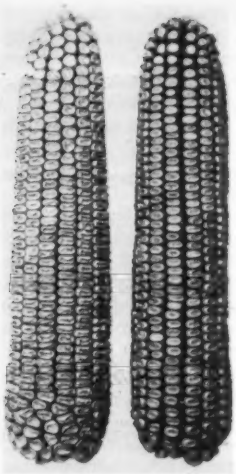

Fig. 9. From the photograph it would appear that the maize ear on the left has 12 rows of kernels and the ear on the right has 14 and that each ear has approximately 50 kernels per row. Based on these figures, the total kernels per ear would be 600 (left) and 700 (right).

in a fasciated type. Most commercial hybrids have about 16 to 18 rows of kernels. According to Anderson and Brown (*15*), row-number is affected by the degree of condensation or telescoping of the successive internodes. As the condensation index increases, there is an increase in the kernel-row-number. It is thought that maize types with a kernel-row-number of 16 or less do not carry condensation factors. Kernel-row-number will vary among plants of a given strain or variety, the range of variation depending upon the genetic purity of the type for row number. However, there is usually a predominance of a certain kernel-row-number that characterizes the type (*16*). Kernel-row-number is the first ear characteristic determined; it is determined when the spikelet-forming branch primordia are initiated in the circumference of the base of the ear shoot primordium (*6*). If several ear shoots on the same plant are examined, beginning with the topmost and proceeding downward, it will usually be found that the topmost shoot has the greater kernel-row-number (*12, 17*). The number of kernels per row is determined by the growth in the length of the ear shoot. As the ear shoot grows in length, spiklet-forming branch primordia are formed in acropetal succession beneath the apex of the shoot. The duration of the period of growth of the ear shoot in which functional spikelet primordia are produced has not been determined. In fact, little is known about the cause of variability in kernel-row-number and in the number of kernels per row even though their direct relationship to variation in seed yield can be clearly demonstrated.

Lateral shoots are produced in the axil of each leaf. Each axillary shoot is a potential branch that may develop into a negative shoot (tiller, sucker) or into an ear shoot (Figs. 7 and 10). If the tiller develops during the early stage of plant growth, it may become almost as large as the main axis and produce an ear in the same manner as the main axis, or it may produce seed mainly in the central axis of its tassel.

The value of the tillers on corn plants has been questioned for many years; they have been called suckers, owing to the early belief that they were parasitic and, hence, reduced the grain yield. However, investigations cited by Dungan (*18*) showed that plants with tillers yielded more than plants without tillers, although the difference was not significant. When all the leaves were removed from the main stem at the early milk stage of seed development, the plants with tillers were significantly superior to plants without tillers in yield of grain, test weight per bushel of the seed, weight of 100 kernels, diameter of ear, length of ear, and weight of the ear-bearing stalk. Using ears from single-plant hills, Carter and Dungan (*19*) compared ears from plants with tillers and ears from plants without tillers and found that the plants with tillers yielded 14.5 percent more grain. Based on 5 yr work, Kiesselbach (*11*) showed that the main stalk of tillered plants yields only 2 percent more grain than plants without tillers, but, if the grain yield of the tiller is included, the total yield of grain per plant is 42 percent greater. Hybrid corn breeders have tended to select for the nontillering habit for several reasons, one of which is that maize that does not tiller is easier to harvest. However, the question of whether

Fig. 10. A maize plant with leaves and a maize plant with leaves removed to show the development of the basal axillary shoots, which at this stage of development are called tillers or suckers. [Photo by H. R. Lathrop, Ext. Agron., Purdue University.]

or not the capacity to tiller is a desirable characteristic has not been clearly answered.

A maize variety may produce one, two, or more ears per plant. Under favorable growing conditions, the ear of the single-eared type is usually larger than each of the individual ears of the multiple-eared type, but the total yield of a plant of a multiple-eared type may be greater than that of the single-eared type. The Illinois two-eared strain of maize was grown in two yield tests at the Illinois Agricultural Experiment Station. One test was conducted during a period of 18 yr by the plant-breeding division, and the other test was conducted during a period of 13 yr by the crop-production division. The 18-yr average was 58.1 bu/acre for the two-eared strain and 55.5 bu/acre for Reid Yellow Dent (essentially a one-eared strain), a difference of 2.60 bu/acre in favor of the two-eared strain. In the 13-yr test, the two-eared strain yielded 75.8 bu/acre and Reid Yellow Dent yielded 71.2 bu/acre, a difference of 4.6 bu/acre in favor of the two-eared strain. In the latter test, the maximum yield of the two-eared strain was 102.3 bu/acre and that of Reid Yellow Dent was 85.0 bu/acre, both occurring the same year, 1923. The significance of these differences has not been determined. It can also be shown that certain multiple-eared types of maize will outyield certain single-eared types when environmental conditions are limiting. However, in spite of some evidence that multiple-eared types yield more than single-eared types, published evidence was not found which would show that if two types of maize were genetically alike, except for the number of ears per plant, the multiple-eared type would always yield more than the single-eared type.

## The Maize Kernel

A maize kernel is a fruit composed of the fruit coat and the seed. The fruit coat, called the pericarp, consists of several cell layers. The seed consists of three major parts—seed coat, endosperm, and embryo—each of which can be further subdivided (*20*). Approximately 82 percent by weight of a kernel of dent corn is endosperm, 11 percent is germ, and 7 percent is pericarp, seed coats, and tipcap.

The major chemical components of the maize kernel are carbohydrates, protein, oil, and ash. A medium-protein corn contains about 83 percent carbohydrate, 10 to 11 percent protein, and 4.3 percent oil. Although all parts of the seed contain carbohydrates, protein, and fat, the endosperm may be characterized as high in carbohydrate (starch), medium in protein, and low in oil. On the other hand, the germ is high in oil, high in carbohydrate, and low in protein (*21*).

The percentage of protein or oil can be increased or decreased by selection. This has been demonstrated by 50 generations of selection in the Illinois chemical strains of maize. Selection was begun in 1896 in an open-pollinated variety, Burr White. The original variety had an average oil content of 4.70 percent and an average protein content of 10.92 percent. After 50 generations of selection, the average oil content of the Illinois high-oil strain was 15.36 percent and that of the Illinois low-oil strain was 1.01 percent; and the average protein content of the Illinois high-protein strain was 19.45 percent and that of the Illinois low-protein strain was 4.91 percent. Progress is still being made in selection in the high-oil and high-protein strains; however, little progress appears to have been made for the last 15 to 20 generations of selection in the low-oil and low-protein strains. Recovered lines from backcrosses of the high-chemical strains to standard inbred lines have been used in hybrid combinations. Hybrids have been produced that yield well and produce more oil or protein per acre than the standard commercial hybrids with which they were compared (*22*).

## Maize, a Superior Seed Producer

In its range of adaptation, maize as a seed producer is superior to other cereals grown under the same conditions. There are three major factors that contribute to its superiority in seed production: (i) the maize plant is large, (ii) branching is suppressed, and (iii) seed production is confined to a lateral pistillate branch. Weatherwax (*7*) was of the opinion that the superiority of maize as a seed producer lay in the suppression of all but a few branches and in an exceptionally large seed.

The maize plant is much larger than the plant of any other cereal grain, except certain varieties of non-dwarf grain sorghums. At tasseling, a plant of a good hybrid will have from 16 to 18 functional leaves (Fig. 1). Based on an average of 18 $F_1$ hybrids, Sprague and Curtis (*23*) found that a maize plant could have a leaf surface of 5.7 ft$^2$. On this basis, an acre of maize at a population of 14,000 plants per acre would have 1.85 acres of leaf surface. Kiesselbach (*11*) estimated that the leaf surface per acre of corn amounted to 1.64 acres. Based on the average of five grain sorghum varieties grown for 5 yr, Swanson (*24*) found that the leaf surface per acre of grain sorghums ranged from 0.55 to 2.6 acres. No data were found on the extent of the leaf surface in an acre of wheat or oats grown in the United States. From data given by Watson (*25*) on the leaf surface of wheat varieties grown in England, it was calculated that an acre of wheat could have from 1 to 1.2 acres of leaf surface. All estimates of leaf surface are based on one side of the leaf. From the few data available, it does not appear that the leaf surface per acre is the important factor in the superiority of maize as a seed producer.

In maize an extensive, well-organized vascular system is found, both in the large solid stem and in the lateral shoot and ear. The maize plant also has a large and extensive root system. It has been reported by Martin and Hershey (*26*) that the diameter of the main stem is highly and positively correlated with the number of vascular bundles in the stem and with the number and size of the uppermost whorl of soil roots. Concomitant with the over-all size of the maize plant is the corresponding size of the separate parts, all of

which contribute to the development of a large amount of seed per plant and a high seed yield per acre.

It has already been pointed out that branch development in maize is suppressed to the point where only one or more lateral branches develop (Figs. 1 and 7). Plant breeders have contributed by selecting nonbranching types. The vegetative development of the lateral ear-bearing branch is also suppressed to the point where there is little or no internode elongation, and leaf development is restricted to the development of the leaf sheath (husks) without a blade, or only a very small one. The ear-producing branches are pistillate, only seed being produced. This combination of characteristics aids in the concentration of the growth potentials of the plant into seed production.

The position of the ear shoot or shoots on the plant may also be an important factor in the high seed yield of the maize plant. The topmost ear shoot is placed so that there are six to seven morphologically younger leaves above it. Below the topmost ear shoot there may be ten or more morphologically older leaves. Thus there is a large photosynthetic area both above and below the ear, so that materials essential for growth can move downward and upward. Other cereal grains develop their seed in terminal inflorescences with all the leaves below them. The importance of the leaves above the ear shoot is shown by some data obtained by Dungan and Woodworth (*27*). They found that the removal of the topmost one to four leaves with the tassel, when hand tasseling was done, reduced the seed yield. The reduction in yield below that of plants with tassels was 8.3, 15.3, 18.0, and 29.0 bu/acre for the removal of the first, second, third, and fourth leaves, respectively.

All the factors that contribute to the superiority of maize as a seed producer have not been mentioned. It seems that the plant characteristics that are discussed here make an important contribution to the superiority of maize as a seed producer. However, few or no data are available that bear directly on the question. Although much has been learned regarding the maize plant, much is yet to be learned regarding the correlation between morphological and physiological characteristics of maize in the production of seed.

## Summary

1) The development of the maize plant, from germination to the maturation of the seed, is divided into the vegetative, transitional, reproductive, and seed stages. The ear and tassel differentiate and develop in the reproductive stage.

2) The mature tassel is a terminal, staminate inflorescence consisting of a symmetrical, many-rowed central axis and asymmetrical, two-ranked lateral branches. Paired spikelets, one terminal (pedicellate) and the other lateral (sessile), each containing two functional staminate flowers, are borne on the central axis and the lateral branches.

3) In contrast with the tassel, the ear is a pistillate inflorescence produced on a lateral branch. The ear consists of a symmetrical, many-rowed axis on which are paired spikelets, each containing two flowers. In the mature ear, it is difficult to distinguish the pedicellate from the sessile spikelet. There are two pistillate flowers in each spikelet of the ear, but only the terminal flower is functional, while the lateral flower aborts.

4) The mature ear and tassel appear to be different kinds of inflorescences, but if they are examined at the earliest stages in their development they will be found to be basically alike. The differences in the appearance of the two inflorescences at maturity are the result of differences in the differentiating and development of their parts.

5) Each of the morphological characteristics found in the maize inflorescences, except one, is present in other grasses, but the collection of morphological characteristics found in the ear and tassel is unique. One morphological characteristic not found in other grasses but found in the maize ear is the presence of a terminal, fertile, and aborted, lateral flower in each of the paired spikelets.

6) Axillary shoots are produced in acropetal succession in the axil of each leaf. Some of the axillary shoots that are produced at the beginning of the development of the plant may develop as tillers (suckers). The last-produced axillary shoot (or shoots) that is far enough advanced in its development at the initiation of the tassel develops into the ear (or ears).

7) The amount of seed produced per ear is determined by the number of rows of kernels and the number of kernels per row. The number of rows of kernels is determined at the beginning of the initiation of the ear, but the number of kernels per row may vary with the strain and with changes in the environment. Under comparable condition, seed produced per ear is less in plants without tillers than in plants with tillers. The average seed yield per ear is less in multiple-eared types than single-eared types growing under similar conditions.

8) The three major parts of the maize kernel are endosperm, 82 percent; germ, 11 percent; pericarp, seed coats, and tip cap, 7 percent. The composition of the maize kernel is 83 percent carbohydrate, 10 to 11 precent protein, and 4.3 percent oil. Fifty generations of selection for high- and low-protein strains and high- and low-oil strains produced marked changes in the chemical composition of the maize kernel. Beginning with 4.7 percent oil, after 50 generations of selection, the high-oil strain has 15.36 percent and the low-oil strain has 1.01 percent of oil. The protein content was 10.92 percent at the beginning of the selection and reached 19.45 percent in the high-protein strain and 4.91 percent in the low-protein strain after 50 generations of selection. Recovered inbred lines from backcrosses to the high strains have resulted in good-yielding hybrids that produce more protein or oil per acre than standard hybrids.

9) Several factors contribute to the superiority of maize over other cereals as a seed producer. The maize plant is large and, concomitant with its size, it has

a large leaf surface, large stem, large root system, and an extensive vascular system. Branching is restricted to a few lateral, pistillate branches in which vegetative development is suppressed. The lateral ear-producing branch (or branches) is so placed on the plant that there are many leaves above and below it. The ear is large in diameter and has seeds that are many times larger than those of other cereals. All the afore-mentioned characteristics, many of which are not present in other grasses, contribute to making the maize plant a superior seed producer.

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# A New University


**William Seifriz**

*Botanical Laboratory, University of Pennsylvania, Philadelphia*


THE current issue of the *Annual Review of Physiology* has just come into my hands. In the prefatory chapter, Otto Loewi deplores the trend that science and its literature have taken. As I read, and so wholeheartedly approved, I wondered whether this trend, which seems inescapable in our modern life, need necessarily affect all living and thinking. Loewi's plea for a greater emotional appeal in science is, in reality, a groping for something of basic moral value. He says:

> A scientific worker nowadays rarely finds it possible to publish papers which have a personal touch; [he is not permitted] to discuss the origin and development of his problem, to draw conclusions of hypothetical character . . . such revelations are not found in the ordinary papers which fill the scientific journals.

Loewi then quotes a remark made by one of his students:

> For me the most exciting papers are those which describe exactly what the individual scientist experienced from the beginning to the end of his experiments, the mistakes he made and how he learned through them what the answers were.

One of my own former students, now a research worker in his own right, came to me the other day and, as he handed me a manuscript, said: "What shall I do? This is a good article, the best I've written. The editor accepted it provided that I omit all discussion and my conclusion. That leaves only the data!" "That is all the editor and his critics want," I said. "Send it to Europe." He did and it was accepted in full. These two students have struck at the very roots of our university and of our social life as well.

I had a chapter on adsorption. The critic objected to irrelevant facts: "Cut the history and the ancient guessing, and tell the student what adsorption *is*, then stop." Do we know what adsorption is? That master of adsorption chemistry, Herbert Freundlich, thought otherwise. He taught that the adsorption bond can be anything from primary valence to the loose attraction between gases and metals. The critic also objected to my insistence that adsorption is often nonstoichiometric. "A discarded view," he said. For me, the nonstoichiometric proportion between adsorbent and adsorbate is the very essence of adsorption and of colloid science in general. I turned to the writings of America's foremost authority on adsorption and found such statements as

> In general, surface adsorption must be considered as nonstoichiometric . . . nitrogen is held exclusively by physical adsorption on iron below 100°C and by chemical adsorption above this temperature.

There was another chapter on the rheology of biological fluids. The European editor wanted 150 printed pages. The author answered: "According to American standards that is too much." The editor replied, "You Americans write terse articles; we over here like to know how a subject developed. You write for the expert, the experimenter; we for the student and scholar." This last remark brought to my mind the English comment that Americans are "uneducated experts." The author did what the European editor asked and what Loewi would approve—he gave the background of the subject. The first American comment after publication was, "There's no excuse for so long a chapter."

Now what was the real trouble with these critics? It was not objection to the facts presented, as they implied, but rather impatience with the very quality in scientific writing that gives the student a background.

To test Loewi's philosophy—and it is a philosophy—I sought out two books, one a readable 600-page volume and the other a terse 275-page one, both covering the same subject, and asked for an opinion from my students. Their composite answer was: "The first book we enjoyed, the second gave us nothing; we just could not get started." Wondering what the two publishers had to say, I sent inquiries to them. The publisher of the first book replied that it had gone into four printings and was now sold out. The publisher of the second book reported that it had not paid expenses; copies were still to be had from the first and only printing. Apparently, students want what Loewi asks for: "lines of thought by which the discoveries have come about"; in short, the development of a problem.

I wrote on water of crystallization. "Why tell the students what Bragg thought 20 years ago, instead of telling them what we now know to be true," a critic wrote. But what is it that we now know to be true? Is it the nature of water of crystallization? Let us see. The adsorption of water vapor on certain inorganic gels, such as the silica gel,

> . . . is combined so intimately with the surface of the gel that it may have a binding in the range of 50–75 kilocalories per mole of water. On the other hand, a considerable amount of adsorption of water vapor on silica gels can be shown to be of a physical variety that is very easily removed by evacuation at room temperature.

This quotation from an authority is good science and good teaching.

A physicist was much upset because the plus and minus signs had been incorrectly placed beside the short fat line and the long thin line that are symbols for the poles of a Daniell cell. In 1887 Ostwald used the minus sign for the zinc electrode; in 1889 Nernst said that zinc is positive; in 1893 Ostwald switched to the positive sign; in 1900 Nernst did the same; in 1908 everyone was using the minus sign as a matter of course, at least in England and Germany; in the United States the practice does not yet appear to be uniform. Just what is it we now *know* to be true?

What these critics wholly miss is that the student, in hearing the historical background, is better prepared to accept new ideas, which are sometimes resurrected old ideas. If the student of 30 years ago has been told that light was once thought to be corpuscular but is now believed to consist of waves transmitted through the "ether"—that "imaginary substance postulated to convey a physicist's misconceptions from one place to another"—then that student is better prepared to accept, when he is 30 years older, the "new" corpuscular theory of light and with it discard the ether.

Apparently, human nature is such that, in becoming a scientist, one makes oneself either a collator and computer of data or a visionary dreamer in the false belief that the two characters are wholly incompatible.

It is the dreamer in science who has given us what we know of natural laws. From him comes the initial spark that sets a matter-of-fact experimentalist on the road to discovery. Von Laue thought that the symmetrical distribution of atoms in a crystal presents a lattice sufficiently fine to scatter the exceedingly small waves of x-rays. The idea appeared to be scientifically sound, at least to von Laue, but to certain of his colleagues, all classicists, it was untenable. The kinetic energy, or heat movement, of the atoms would, they said, disturb the diffraction phenomena and obscure the picture. But von Laue had confidence in his hypothesis and the courage to see it through. In his laboratory, there were two assistants, both able experimenters, and they proved the truth of von Laue's speculation.

Clerk Maxwell, whose contributions greatly enriched the inheritance left by Newton and consolidated the work of Faraday, was as sound a mathematical physicist as the world has produced, yet he was a dreamer. His first recollection, he tells us, was that of lying on the grass before his father's house and looking up at the sun and wondering.

Another dreamer was Kekule. One summer evening he was returning by the last omnibus through the deserted streets of London. "I fell into a reverie," he says, "and lo, the atoms were gamboling before my eyes." Thus the structural formula of the benzene ring was born.

Strachey wrote of Francis Bacon, "It is probably always disastrous not to be a poet. His imagination with all its magnificence was insufficient; it could not see into the heart of things." And so it is with all true scholars. Helmholtz, physician, biologist, and physicist, said that his best mathematical ideas came to him spontaneously, while walking in his garden early in the morning.

It is no matter of chance that the greatest scientists of all time, Copernicus, Newton, Kepler, Linnaeus, Faraday, Darwin, and Maxwell, were men of noble character, modest, straightforward, and full of human

sympathy. The great French mathematician, Henri Poincaré, stated that the chief end of life is contemplation, not action. George Sarton tells us that we need purer knowledge, not more knowledge, and knowledge that is less harsh. In a somewhat different way, William Wheeler said the same thing:

> We should all be happier if we were less completely obsessed by problems and somewhat more accessible to the esthetic and emotional appeal of our materials.

We condemn European philosophy, and Europeans condemn our technology. The English call us "a nation of gadget makers." We developed the atom bomb, but the basic concepts of atomic fission came from Europe, from within a relatively small circle that reached from Berlin to London and from Paris to Uppsala. Here Rutherford, van't Hoff, Arrhenius, Niels Bohr, Max Planck, Nernst, and von Laue lived and worked. I have spent many months, off and on, in this circle, and no scientific experiences of my life are equal to those lived there. The seminars with Fritz Haber, Freundlich, Warburg, and Polanyi were inspiring episodes, devoid of narrow specialization and the pedanticism of teachers.

Research technicians are often very able men, and their contributions are the technical foundation of science. One need only mention Michelson, as necessary an adjunct to the advance of science as was Einstein who used his data. So let me give full credit to the young and enthusiastic research workers, full of high-energy phosphate bonds. What I deplore is their attitude of mind. Science has become tough, and the students learn to accept it that way.

Recently, three of my former students called upon me and recounted their experiences under new professors. One of these new intellectual guardians was a "swell guy; he called the dean a bag of peanuts." My heart sank as I realized what a failure I had been, for I could not remember ever having called our dean a bag of peanuts. Another boasted that his professor "swore like a trooper"; and the third told how his new chief was the first on his feet at every meeting to ask a question no matter what the subject. This might all seem trifling, but is it so very different from the type of hero worship prevalent among our high-school students who, today, are a serious community problem? Are we, the teachers, not worshiping false gods and presenting false values to our students? Enthusiasm is high, but where are the broad-mindedness, imagination, humility, and deep devotion for which Loewi pleads?

Our scientific congresses are a hodgepodge of trivia. The conversation is that of men on the defensive. An incident that made a deep impression on me recently was the sudden change in voice of a fellow-scientist when I spoke to him. He was, as were most others at this large gathering, very busy speaking loudly and vigorously as if to maintain prestige through sheer force of voice. As I approached, he addressed me in the same manner, but when I asked a question in a subdued tone, his voice suddenly dropped to that of a normal man. The next 15 minutes was an intellectual treat, for he is a brilliant man. His previously forced and artificial manner was in keeping with the times. Science has become tough.

Loewi pleads for an education that will acquaint students with principles that transcend the boundaries of a special field. He expresses a hope that is impossible to fulfill in a modern university, where conformity dictates behavior and definitions define the teaching. The average man is cautious and dull. Little things are important to him—definitions, correct pronunciation, the proper verb for *data*, the species of a genus written large when it should be small, or should it? His life is guided by them. "In science we define our terms!" All right, my good fellow, define *time*.

I am not unsympathetic toward a pedantic view, because, in a sense, I too am a purist who still prefers the King's English to Brooklynese, although I fear the latter will win out in the end. But when pedanticism takes the place of scholarly learning, I rebel. I do not mind our medical schools and colleges of engineering being trade schools, for this is what they are intended to be. When a surgeon ties up my hernia or an engineer builds a bridge that I am to cross, I want no philosophy to enter into the work. But have you noticed how beautiful a well-built bridge can be? Goethe knew this—which reminds me of an article recently rejected because Goethe was quoted. The author commended Goethe's concepts of the meaning of form. I wondered whether the critic condemned the article because of antebellum resentment, or because he could not comprehend Goethe—many persons cannot—or because he felt that philosophy had no place in science. Goethe, as a philosopher, was often wrong in fact but never in principle. His insight is well shown in the first part of the following sentence, and his good sense is revealed in the last phrase: "Your poetic sense should always accompany you but never lead you." There arises in scientific work, says Loewi, "a feeling which can only be described as religious." Einstein called it "cosmic religious experience."

While this manuscript was being written, an article by Richard Goldschmidt appeared, entitled "Different philosophies of genetics" [*Science* **119**, 703 (1954)]. Herein is expressed a view that is essentially the same philosophy of science that I advocate. Goldschmidt writes,

> . . . the statistical attitude calls for explanations in terms of additional genes for whatever has to be explained, while the physiological attitude looks for interpretations in terms of genic action upon development.

In short, Goldschmidt wishes to replace the static and limited statistical method of classic genetics with a dynamic and natural philosophy.

Technicians, teachers, and trade schools are all necessary; science and education cannot advance without them. But can we not have a university as well, a real university such as Padua had? It will have to be a *new* university if we are to accomplish anything in it, a guild of scholars such as Padua was.

The position of the university in ancient times was a strong one. It absorbed from the church the rights

of higher learning. The status of professor attained a dignity that surpassed, in many instances, the dignity of a bishop or a nobleman. The call to a chair at Padua or Pisa was deemed the greatest honor. This spirit of unfettered liberalism was maintained throughout the Middle Ages, and the university developed into a democratic guild whose independence was recognized by all and blessed by the church. The titular head of the university was the rector, but his duties were purely perfunctory. The university of old had many of the attributes of the church. It was an asylum for the persecuted, a political and intellectual sanctuary. There was respect for learning, a respect that is almost unknown today.

Thus, there arose a tradition of protection, of liberty in action, and of freedom in thought. Neither royal charter nor papal bull hampered academic expression; on the contrary, they guaranteed it. The university became the intellectual center of the community.

From this delightful situation, the universities gradually drifted, until during the 16th and 17th centuries, their democratic constitutions were superseded by small oligarchies of officials. Rectors, deans, and proctors banded together and acquired control. Thus, an intellectual feudal system was established that persisted, for example, in France until the whole was swept away by the French Revolution. For another century the universities of Europe again enjoyed their ancient freedom.

One is impressed by the similarity of this situation to that in the American university today. James Ewing, of cancer fame, once wrote that whereas a demotion or dismissal is readily pushed through an American college, such drastic action could not possibly occur in a European university without a thorough investigation and the approval of the faculty. Demotions and dismissals in American universities are rarely justified. They merely give someone the courage to live.

Ewing entertained one false hope. He said, "Put a self-effacing man in power." One cannot help but smile at this remark, so contrary is it to experience. The only answer for the true university is not to put any one man in power. This is essentially the situation at the Sorbonne. The faculty is in charge, and not one among them has the power to wield a whip hand over his colleagues.

The new university should not be large; it need not be, for our universities today are crowded with students who neither desire nor need a higher education. The girls are there to spend their maturing years in some advantageous way until marriage. A group of them in a small college went to the dean and demanded a revision in their curriculum. "Nothing but mathematical equations, scientific experiments, languages, and the appreciation of art, but not a word on how to live." I am inclined to think that the girls were right.

The majority of the boys are in college in order to acquire the fundamentals of a profession. For the average man, the junior college is sufficient. The French *lycée* and the German *Gymnasium* are the European counterparts, and they give excellent schooling. The professional man must go higher through his particular specialized school. There is nothing arrogant or snobbish in these statements concerning the majority, for every person will have the right to attend the new university. We ask only that he want it and be equal to it. Education, like art, can be appreciated only by those who understand it.

Many persons will not take this plan for a new university seriously. They will not regard the situation as deserving of so much concern. If the fate of civilization the seriousness of lawlessness and of juvenile delinquency, and the need of an intelligent understanding of one's fellow-men are of no importance, then well and good. Let every man live for himself alone in any way that he wishes. There are persons who think this way.

There is another aspect of the problem that disturbs me. The books that have sold well recently bear such titles as *Peace of Mind, Life Is Worth Living,* and *Faith and Prayer*. Each and every one is an appeal "to return to God," just as if we had lost Him or He us. To all this, I heartily agree. Many men and women have told me that were it not for their Sunday-School training as children they would never have acquired a real knowledge of right and wrong. But there are weaknesses in this trend back to religion of which the university man should take cognizance. The appeal is purely emotional, the reasoning often biologically unsound, and the approach too sentimental. Wholly lacking is the "righteous wrath" of which the Bible speaks. Man is half animal—I was about to say, and let us handle him accordingly, when I glanced at the well-run society of animals outdoors and wondered whether the animal half of man is not the better half.

Religion is a power for good, but it is not enough. Youth craves action, and science has given it to him in death-dealing forms. In a recent article, Kirtley Mather [*Science* **119**, 299 (1954)] writes of a scientist's obligation to the layman. The obligation goes further; it is not an obligation of the scientist alone but of the university as a whole. People expect goodness from the church, justice from the state, and enlightenment from the university. Enlightenment is more than knowledge. It is knowledge softened by understanding, and in this respect science has failed.

The stupid expression, "the scientific way of life," is meaningless. Science does, to be sure, seek the truth regardless of the consequences, and to this extent it is good, but of what did it boast during the war? Printed in red letters across its journals was, "Science Is Power." If this is all it is, then the less we have of it the better. The pursuit of science is a wonderful experience, but we have degraded it by the use to which we have put it. At best it is not a way of life.

Can we not have, somewhere in our society, a center, or many centers, from which will emanate a culture that man will respect, an intelligent biological system of ethics? The more biological it is, the more intelli-

gent, the more kindly it will be. I know of no institution that can house such a way of thinking other than the university, but it will have to be a new university. Perhaps you will say, "Men will no more respect it than they now respect anything in heaven or on earth, for do not churchmen make the Deity partner to their chicanery and do not city politicians pray?" Just so do men of learning use their status in science and the university as proof of their superiority, a conceit that often leads to vicious acts. This is all true, and yet I say you are wrong. I have not taught students for 30 years without noting how quickly and well some of them judge their teachers and how great is their respect for the scholar. This is, of course, not true of all, but the students who are capable of such judgment will set the standard for the rest. I have seen older men, those who once held power in a college where they had absolute and tyrannical control, become, literally overnight, quite decent men when they entered an institution of higher learning.

And so I come to my conclusion. Loewi's appeal is not merely a "great concern about the future of medical physiology because of the increasing schisms," nor is it just a cry, deploring with Howard Mumford Jones "the increasing tendency to train scientists predominantly as superb research technicians rather than carriers of a flame," nor is it only an appeal for a scientific literature that is interesting to the student: it is a prayer for "belief in the meaningfulness of the universe." Many will say that this is nothing more than religious faith. I have no objection to this, and perhaps it is true. But it carries with it the tragic admission that science and academic learning have failed. This failure is not necessary.

# *News and Notes*

## Ichthyologists and Herpetologists

The American Society of Ichthyologists and Herpetologists, a new affiliate of the AAAS, can trace its beginning back to 27 Dec. 1913 when the first issue of a 4-page pamphlet entitled *Copeia No. I* was published. Its announced purpose was to advance the science of cold-blooded vertebrates. The founders were a group of men in the American Museum of Natural History in New York and the Academy of Natural Sciences in Philadelphia who felt the need of an additional outlet for short notes. The initial number had an article on turtles, one on lizards, two on fishes, and one on a frog. John T. Nichols was the first editor. In 1916, after *Copeia* had been appearing for about 3 yr during which more than 30 issues were published, the A.S.I.H. was organized in New York at the American Museum of Natural History. The second annual meeting was held at the Academy of Natural Sciences in Philadelphia, and the third at the Museum of Comparative Zoology at Harvard.

In 1924, *Copeia* started carrying the statement "Published by American Society of Ichthyologists and Herpetologists" and officially became a monthly, although it had been one, in fact, since its start. But it was still a pamphlet until 1930, when it took its present form and became a quarterly of approximately 300 pages per year. In addition to the journal, the society has recently published the sixth edition of the *Check List of North American Amphibians and Reptiles*, by Karl P. Schmidt. A check list of fishes is planned.

A special function of the society is the maintenance of a revolving fund that is available to members who need help in expenses involved in publication, collecting, or transportation. A grant is not a loan, but it is hoped that recipients, when they are in a more favorable financial position, will replenish the fund.

Since the organization of the society, meetings have been held yearly without interruption, except during World War II, and the 34th annual meeting will take place in September in conjunction with the convention of the American Institute of Biological Sciences at the University of Florida. Annual meetings last about 3 days and are devoted to papers on herpetology and ichthyology, usually presented in separate sections. Occasionally joint sessions are arranged if enough papers of general interest have been submitted. Small cash prizes are given for the best student work in each field.

The A.S.I.H. is a member of the A.I.B.S. and also makes an annual contribution to the support of the *Zoological Record*. Two functioning divisions have been organized, the Southeastern Division and the Western Division.

The society has approximately 1200 members. In addition, 300 journal subscriptions go to institutions and agencies. Membership is world-wide, with of course the greatest bulk in the United States. It is made up of a fairly representative cross section ranging from eminent specialists through students and amateurs. The society is open to all persons interested in advancing the knowledge of the cold-blooded vertebrates.

ARNOLD B. GROBMAN, *Secretary*
*Florida State Museum, Gainesville*

## Science News

The National Institutes of Health, Bethesda, Md., has received as a gift from the Liggett and Myers Tobacco Co., a 3,000,000-v **Van de Graaff generator** constructed in 1950 for an experimental program of the company. The 30-ton apparatus is being installed in the radiation wing of the new 500-bed Clinical Center at NIH, where it will be used in research on the biological effects of high-energy radiation. It operates

under high pressure inside a steel tank and is capable of delivering more than 12 kw of electrical energy, thus enabling study of the effects of radiation delivered at dose rates not heretofore achieved in the laboratory.

In April the Nevada Supreme Court ordered the University of Nevada to reinstate **Frank B. Richardson**, professor of biology, who was dismissed a year ago on charges of insubordination because he opposed the University Regents and the President in their move to lower entrance requirements so as to admit any Nevada high school graduate, whatever his grades [*Science* **118**, 154 (1953)]. In thus upholding the contractual rights of university professors with tenure, the Nevada Supreme Court has strengthened academic freedom throughout the land, in a period when it has been woefully weakened by a variety of pressures. In Nevada it is to remain possible for a scientist to express his views about educational policies affecting the teaching of science without fear of dismissal from his post. Since one of the prime charges against Prof. Richardson was that he had circulated among his colleagues copies of an article on education reprinted from *The Scientific Monthly* [Aug. 1952, p. 109], it is particularly encouraging to the editors that freedom of thought and discussion has prevailed.—*B. G.*

Information has recently been released about an untried design for the world's first commercial, **nuclear-fueled electrical power house.** The core of its furnace, which is to be built by Westinghouse Electric Corp. for the Duquesne Light Co. about 25 mi northwest of Pittsburgh, will weigh more than 10 tons. It will be made up of natural uranium and the U-235 isotope.

Capsuled in a cylinder 6 ft in diameter and 7.5 ft high, the reactor is designed to accommodate even larger cores if in the future they seem desirable. It can accept cylinders up to 9 ft in diameter and 25 ft high.

Some 20,000 lb of uranium, which contains slightly more of the U-235 isotope than the natural element, will generate surface temperatures up to 335°C, which is the boiling temperature of water under a pressure of 2000 lb/in². Water at this pressure will circulate through three loops from reactor to a heat exchanger, carrying off enough heat to develop 60 megawatts of electric power. A fourth loop is held in reserve for emergencies. About 16,000 gal/min can be pumped through each loop.

This first nuclear reactor power plant is not expected to produce electric energy at a price competitive with current rates, although the hope is that the cost will not be much higher. The actual design is nearing completion, and ground-breaking should take place sometime this fall. The whole project should be finished in about 4 yr. It is an $85,000,000 installation, including the generating and substation equipment that the Duquesne Light Co. is financing. The company also is contributing $5,000,000 toward the development of the reactor, and plans to buy steam from the reactor at 8 mills/kw hr of electric energy generated. The latter arrangement will, in effect, save the government about $30,000,000, bringing the government's interest in the project to $50,000,000. The Duquesne Co. also will man and operate the entire plant at no cost to the government.

In an article scheduled for a forthcoming issue of *Science*, Saul Rich and James G. Horsfall describe the correlation of **fungitoxicity** with an orderly reshaping of a potentially fungitoxic molecule. It is believed that the change made, increasing the length of the alkyl side chain, increases the amount of toxicant penetrating into the fungus.

Correlating chemical structure with biological activity is an extremely active field of research. Great numbers of workers in almost every major branch of biology search diligently for clues to explain the effects of biologically active compounds. These researchers have been spurred on by two main interests: the use of these studies to trace the pathways of biological mechanisms; and the possibility that the biological activities under study may in some way solve an important problem in applied biology. So it is that compounds identifiable by their structure as possible antimetabolites have been useful both for studying microbial metabolism and for combating bacterial infections. Plant-growth hormones, now known to require certain chemical configurations for biological activity, have been useful both for studying plant metabolism and for solving agricultural problems. However, the biological activities of certain groups of compounds have not been adequately correlated with chemical structure. One such group is the fungitoxicants. It is in this group of compounds that we look for tools to study fungus metabolism and for fungicides to protect wood, fabrics, paints, plastics, and agricultural crops against depredations by fungi.

**Oil** that lubricates even at −100° F has been developed by Elgin National Watch Co., Elgin, Ill. It is expected to eliminate one of the great obstacles to successful arctic military operations.

***Manpower Resources in Mathematics,*** a report on the professional characteristics, employment, and earnings of mathematicians in the United States, has been issued by the National Science Foundation. The report, prepared jointly by the Foundation and the Bureau of Labor Statistics of the U.S. Department of Labor, is based on information supplied to the National Scientific Register in 1951 by about 2400 mathematicians. Nearly 1500 of the estimated 2000 mathematicians in this country who hold Ph.D. degrees in mathematics are represented.

About 90 percent of the Ph.D. survey group were employed in universities and colleges. Of the Ph.D. mathematicians engaged primarily in research, however, 44 percent held appointments at educational institutions, while more than 26 percent worked for the Government and 30 percent were employed in research and as consultants for private industry.

Only 8 percent of the professional mathematicians

with Ph.D. degrees were women, although 15 percent of the non-Ph.D. mathematicians were women. The median age of the Ph.D.'s in the study was 41 yr, somewhat older than in the fields of physics and chemistry, which have expanded more rapidly in recent decades. The median income of the Ph.D.'s was $6200 per year compared with $4400 per year for professional mathematicians without Ph.D.'s. The report is available for 20 ct from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

A very faint **comet** has been found in the constellation of Corona, now directly overhead, by Robert G. Harrington of Mt. Wilson and Palomar Observatories in California. The comet was discovered on 24 June and is of magnitude 19, much too faint to be seen except with the very largest telescope.

Discovery of a possible **index to male fertility,** based on the amount of desoxyribosenucleic acid (DNA) in the spermatozoa, was announced by David R. Weir and Cecilie Leuchtenberger of Cleveland at the recent meeting in San Francisco of the American Society for the Study of Sterility.

In a group of human males of proved fertility, the investigators discovered that the amount of DNA per spermatozoon was very constant and uniform for each person and for the group as a whole. In childless couples, where study of the wife showed she is presumably fertile, the DNA content of the husband's spermatozoa is often abnormal. In such abnormal cases, the routine semen analysis is also usually, but not always, abnormal. In some couples where routine study showed no cause for the childlessness, the DNA content of the spermatozoa is abnormal.

This summer, H. V. Neher, professor of physics, and his assistant Edward Stern, both of the California Institute of Technology, have undertaken a **cosmic ray expedition** sponsored by Caltech, the Office of Naval Research, and the U.S. Weather Bureau. They plan to measure cosmic ray intensities from Charleston, S.C., to the northern tip of Ellesmere Island near the north geomagnetic pole. Helium-filled balloons carrying ionization chambers and telemetering devices will be released to record the intensity of low-energy particle radiation at Charleston, Washington, and Boston. From Boston the investigators will take a Navy icebreaker to Thule, Greenland, where measurements will also be made. Then they will go to Alert, a U.S.-Canadian Weather Bureau Station on Ellesmere Island, to conduct their northernmost studies, after which they will visit Resolute, another U.S.-Canadian Arctic weather post, for final observations.

Sounding balloons reach a maximum height of about 20 mi. Since they are free balloons, most of those released at sea and in the far north will not be recovered, and it is only the short-wave telemetering devices that provide information on the intensities that have been recorded in the ionization chambers. Low-energy nuclear particles arrive in greater concentrations at high latitudes and the current studies involve variations in intensities at various latitudes and longitudes.

To round out the project, two Caltech graduate students in physics will man a station near Bismarck, N.D., for the summer period in order to make readings, according to a prearranged schedule, at times coincident with those made by Neher and Stern. The Bismarck studies will serve as controls by providing simultaneous comparison data made at approximately the same altitude but a different latitudes. Bismarck was chosen because of its northern location, because extensive studies of cosmic radiation have been made in that area on at least six previous occasions, and because it is an area favorable for the recovery of balloon-borne instruments.

A recent count indicates that at least 50 foreign scientists have been refused **visas** in the last 2 yr. The total is probably many times this number, since only a small percentage of the visas denied are heard about in the United States.

## Scientists in the News

**William F. Ashe,** chief of internal medicine at the Holzer Clinic in Gallipolis, has been appointed professor and chairman of the department of preventive medicine in Ohio State University's College of Medicine, effective 1 Oct. He succeeds **John A. Prior,** who has served for several years as acting chairman and in January became assistant dean of the College of Medicine.

**Raymond C. Bard,** head of the microbiology section at Smith, Kline & French Laboratories, has accepted an additional part-time appointment as associate professor of microbiology at Hahnemann Medical College, Philadelphia.

**Nathan Birnbaum,** a member of the chemistry department of the City College of New York since 1929, succeeded **Benjamin Harrow** as departmental chairman on 1 July.

**Harold A. Bolz,** chairman of the department of general engineering at Purdue University, has been named associate dean of the College of Engineering at Ohio State University, effective 1 Oct. In his new post, Dr. Bolz will devote a major part of his time to the development of conference and technical meetings through which the university can better serve Ohio industry.

**Edward D. Churchill,** chief of the General Surgical Services at Massachusetts General Hospital and professor of surgery at the Harvard Medical School, has accepted an invitation from the Department of State to visit the Near East under the International Education Exchange Program. He is spending approximately 3 wk giving a series of lectures and conferring with medical leaders in Lebanon and Syria.

**Carroll Augustus Curtis,** a member of the engineering faculty at the University of Idaho for the past 6

yr, has been appointed an associate professor in the West Virginia University College of Engineering.

**Emile F. Holman,** professor of surgery at the Stanford University School of Medicine, has received the Rudolph Matas award in vascular surgery. He was chosen for his research that set the stage for new types of surgery in heart and artery abnormalities, including the "blue baby" operation.

Dr. Holman will retire on 1 Sept. after 29 yr as head of his department. He will be succeeded by **Victor Richards,** a member of the medical school staff since 1942.

**William White Howells,** formerly professor and chairman of the department of sociology and anthropology at the University of Wisconsin, has taken the place of the late Earnest A. Hooton as the principal physical anthropologist on the Harvard University faculty.

The University of Wisconsin has appointed two scientists—one a chemist, the other a geneticist—to named professorships. **William S. Johnson,** professor of chemistry at Wisconsin, has been appointed Homer Adkins professor of chemistry, and **Sewell Wright,** professor of genetics at the University of Chicago, has been named Leon J. Cole professor of genetics. Both appointments are for 5 yr beginning with the 1954–55 academic year, and both men are first incumbents of the two special chairs.

**Herbert Pollack,** consultant to the Surgeon General, Department of the Army, since 1951, has been appointed associate professor of clinical medicine at New York University-Bellevue Medical Center's Post-Graduate Medical School.

**Charles C. Rabe,** associate professor of pharmacy administration at the St. Louis College of Pharmacy and Allied Science, has been named assistant to the secretary of the American Pharmaceutical Association. He assumed his new duties at the A.Ph.A. headquarters building in Washington, D.C., shortly after 1 July.

**H. P. Robertson** of the California Institute of Technology has been appointed scientific advisor to Supreme Headquarters, Allied Powers, Europe (SHAPE), headed by Gen. Alfred M. Gruenther, Supreme Allied Commander in Europe. He is taking a year's leave of absence as professor of mathematical physics and plans to leave for Paris early this month. The position of SHAPE scientific advisor is newly created by the North Atlantic Treaty Organization (NATO), which authorized Dr. Robertson's appointment. His office is to supply scientific advice on military problems that arise in any of the divisions of Gen. Gruenther's staff.

**Michael B. Shimkin,** chief of the U.S. Public Health Service's Laboratory of Oncology at San Francisco, has been transferred to Bethesda, Md., as chief of the biometry and epidemiology branch at the National Cancer Institute. The Laboratory of Oncology, which Dr. Shimkin headed from the day of its establishment in 1947, was discontinued on 30 June. It had been operated by the National Cancer Institute and the University of California School of Medicine as a cooperative project for cancer research.

The Office of International Relations, National Academy of Sciences–National Research Council, has provided the following information concerning the travel plans of scientific **visitors to the United States and Canada.**

J. W. Cornforth and R. H. Cornforth, Medical Research Council, 38 Old Queen St., London. Here 31 July–25 Aug. to attend the Gordon Research Conference on Chemistry of Steroids at New Hampton, N. H.

J. S. Hall, Animal Husbandry Department, King's College, University School of Agriculture, Newcastle-on-Tyne, Eng. Here beginning mid-July for about 2 wk to attend the World Jersey Cattle Bureau meeting in Guelph, and to visit Beltsville, Md.

Alastair Heron, Medical Research Council, Unit for Research in Occupational Adaptation, attached to the Institute of Physiatry, Maudsley Hospital, London. Here 1 June–9 Sept. to visit centers of interest for research in occupational adaptation.

G. E. Kellaway, Geological Survey, Dept. of Scientific and Industrial Research, London. Arrived in Montreal in May for an indefinite stay to visit northwestern Canada, Alaska, and other areas to study the effects of permanent frost upon soft sedimentary rocks.

R. E. F. Lewis, Medical Research Council's Applied Psychology Research Unit, 38 Old Queen St., London. Arrived in Toronto in April for a stay of 2 yr as an exchange worker with the Defense Research Board Medical Laboratories.

W. C. Lister, head of the Instrument Division and designer of apparatus at the National Institute for Medical Research, Medical Research Council, 38 Old Queen St., London. Here 11 Sept.–20 Oct. to attend the 1st Instrument Congress in Philadelphia.

L. C. Luckwill, Long Ashton Research Station, Agricultural Research Council, 15 Regent St., London is serving as a visiting professor at Cornell University for 1 yr beginning 1 July.

E. M. McGirr, lecturer in medicine in the Muirhead Dept. of Medicine, Royal Infirmary, Glasgow, Scotland. Will come for 3 mo in the fall to observe the clinical use of radioactive isotopes.

A. R. Meetham, Physics Division, National Physical Laboratory, Teddington, Middlesex, Eng. Will arrive in mid-September for about 3 wk to attend the 9th Annual Calorimetry Conference in Schenectady.

Carlos De Andrade Rizzini, São Paulo, Brazil, director-general, Diarios Associados; professor, University of Brazil; director of radio broadcasting, Educational Services, Ministry of Education. Arrived 30 Apr. for 90 days. Trip arranged by Governmental Affairs Institute, c/o Miss Elizabeth Joszick, Programs Branch,

Leaders Division, Dept. of State, Washington, D.C.

H. D. Sawyer, lecturer in nonferrous extraction metallurgy at Royal School of Mines, Imperial College of Science and Technology, Imperial Institute Rd., London. Arrived mid-June for 3 mo to visit U.S. and Canadian centers of nonferrous extraction metallurgy.

R. C. Tomlinson, mathematician, National Coal Board, England. Here 8 June–28 July, to attend the Convention of American Society for Quality Control and an A.S.T.M. symposium in Chicago.

E. K. Woodford, Agricultural Research Council's Unit of Experimental Agronomy, 38 Old Queen St., London. Arrived 25 June for about 90 days to visit centers concerned with research on new crops and selective phytotoxicity.

## Meetings

Fifty sessions, sponsored by the five technical divisions of the **American Institute of Electrical Engineers,** will be held at the Institute's fall general meeting in Chicago, 11–15 Oct. J. F. Calvert of Northwestern University is general chairman. Special emphasis will be on electrical aspects of air transportation, with eight sessions planned on this subject.

The power division is planning sessions on carrier current, insulated conductors, power generation, protective devices, relays, rotating machinery, switchgear, system engineering, transformers, and transmission and distribution. The science and electronics division is scheduling papers on computing devices, electrical techniques in medicine and biology, electronics, and nucleonics.

The industry and general applications divisions will sponsor programs on chemical, electrochemical, and electrothermal applications, feedback control systems, general industry applications, industrial power systems, and land and air transportation.

The most complete gathering of pharmacists, representing every phase of the profession, is scheduled for the week of 22 Aug. at the Hotel Statler in Boston, Mass. Meeting with the **American Pharmaceutical Association** at its 101st annual convention will be the American Association of Colleges of Pharmacy, the National Association of Boards of Pharmacy, the American Society of Hospital Pharmacists, the American College of Apothecaries, and the National Conference of State Pharmaceutical Association Secretaries. These organizations, together with the house of delegates of the A.Ph.A., constitute a complete cross section of all phases of pharmacy and will bring together the leaders of the profession, including those in industry, for discussion of their scientific, economic, and social problems. For information write the American Pharmaceutical Association, 2215 Constitution Ave., NW, Washington 7, D.C.

"Science and the changing patterns of civilization" will be the subject discussed by Gordon M. Shrum, director of the British Columbia Research Council before the 2nd Western Regional Conference of **The Chemical Institute of Canada,** Vancouver, B.C., 10–11 Sept. A feature of the technical program will be the lecture before a general session by Kenneth Pitzer of the University of California, Berkeley. Other fields to be covered by papers include: chemical engineering, biochemistry and nutrition; chemical education; plant products; analytical chemistry; and physical chemistry. Further information can be obtained from Dr. Neal M. Carter, Pacific Fisheries Experimental Station, 898 Richards St., Vancouver.

A microscopy exhibition, **"From magnifying glass to eye of science,"** will be held at the National Museum for the History of Science, Leiden, from 25 June to 19 Sept., coinciding with the International Congress of Cell Biology.

To provide standardization in the vitamin assay of foods in various countries and thus to facilitate international trade, an **International Vitamin Commission** has been organized under the auspices of the food division of the International Union of Pure and Applied Chemistry with Prof. E. Brunius, of the National Public Health Institute, Stockholm, Sweden, as chairman. The additional members are W. F. G. Cuthbertson, Glaxo Laboratories, Ltd., England; Max Kofler, F. Hoffman–La Roche and Co., Ltd., Switzerland; Bernard L. Oser, Food Research Laboratories, Inc., United States; Henri Simonnet, National Veterinary School (Alfort) and National Agronomic Institute, France.

The Commission will attempt to utilize the standardized methods of the numerous organizations within several countries that have engaged in standardization work, and to integrate and adapt these methods for use at the international level.

The fifth **Symposium on Vegetative Neurology,** on the subject "Physiology and pathology of temperature regulation," will take place in Vienna, 30 Aug.–1 Sept. It is sponsored by Acta Neurovegetativa. Inquiries should be directed to Dr. Evelyn Anderson, Chief, Section of Endocrinology, National Institutes of Health, Bethesda, Md., or to Dr. W. Schwable, The Secretariat of the Symposium, Springer-Verlag, Vienna I, Molkerbastei 5, Austria.

## Society Elections

**Alpha Epsilon Delta:** pres., Lloyd R. Gribble, West Virginia University, Morgantown; v. pres., Joseph B. Price, Millsaps College, Jackson, Miss.; sec., Maurice L. Moore, Vick Chemistry Co., New York; treas., Norman F. Witt, University of Colorado, Boulder.

**Illuminating Engineering Society:** pres., Duncan M. Jones, Curtis Lighting of Canada, Ltd., Montreal; v. pres., Marshall N. Waterman, Westinghouse Lamp Division, Bloomfield, N.J.; sec., Kirk M. Reid, General Electric Co., Cleveland, Ohio; treas., George J. Taylor, Day Brite Lighting, Inc., New York.

**Special Libraries Association:** pres., Gretchen D. Little, Atlas Powder Co., Wilmington, Del.; 1st v. pres. and pres.-elect., Chester M. Lewis, *The New York Times*; 2nd v. pres., Isabella M. Frost, Lansing Library Service, Oakland, Calif.; sec., Margaret A. Firth, United Shoe Machinery Corp., Beverly, Mass.; treas., Burton W. Adkinson, Library of Congress, Washington, D.C.

**South Dakota Academy of Science:** pres., Harlan L. Klug, South Dakota State College; 1st v. pres., Frank W. Jobes, Yankton College; 2nd v. pres., Charles R. Estee, University of South Dakota; sec.-treas., A. L. Haines, University of South Dakota; representative to the AAAS Council, Raymond J. Greb, South Dakota State College.

## Education

Brown University will institute this fall an undergraduate curriculum leading to the B.S. degree in **applied mathematics.** The program is designed to train students to translate scientific problems into mathematical form that can be handled by electronic computing devices. During the first two years of the new program, students will take courses in engineering, physics, and chemistry; in the junior and senior years, the application of mathematical methods to these fields will be emphasized. The curriculum will include elective courses designed to broaden educational experience and to encourage the study of other fields in which the application of mathematics offers opportunities.

A 1-wk refresher **course in aviation medicine** for civilians is to be given at the Ohio State University College of Medicine during the week of 13 Sept. The course, which will be 80 percent clinical, is sponsored jointly by the University and by the Civil Aeronautics Administration, and is approved by both the Aero Medical Association and the Airline Medical Examiners Association. Topics to be covered include two half-day sessions on cardiovascular disease and discussions of balistocardiography and vector cardiography. There will be half-day sessions on the following subjects: ophthalmology and visual problems; otolaryngology; endocrine and metabolic disorders; psychiatry; including the problems of the aging pilot; and respiratory and pulmonary function tests.

Nonclinical matters will be covered in lectures on the future of aviation medicine; medical aspects of accelerative forces; the psychological evaluation of airmen; physiological aspects of cabin pressurization; and aviation toxicology. For further information address Dr. Richard L. Neiling, College of Medicine, Ohio State University, Columbus 10.

William C. Van Ost, a graduate this June of the Albany Medical College, has been awarded an Alumni Exchange Scholarship to intern at the University of Sheffield and the Royal Hospital in Sheffield, England, during the next academic year. This is the first year of the **internship exchange** between the two institutions. A British candidate to be sent to Albany is being selected on the basis of an examination held recently in Sheffield.

The first 4-yr collegiate program in **medical journalism and writing** leading to a bachelor's degree has been announced by the American Medical Writers Association. It will begin in September at the University of Illinois and the University of Missouri. Several partial scholarships, sponsored by the AMWA, will be available. Descriptive literature can be obtained from Earl F. English, dean, School of Journalism, University of Missouri, Columbia, or from I. W. Cole, School of Journalism and Communications, University of Illinois, Urbana.

The **U.S. Public Health Service Communicable Disease Center** at Chamblee, Ga., has available a schedule of the laboratory refresher training courses that will be offered by the Center during the period July 1954–June 1955. Information will be sent on request.

North American Philips Co., Inc., and its western dealers will hold the second **Western X-ray Diffraction School** at the Sir Francis Drake Hotel in San Francisco during the week of 30 Aug.–3 Sept. There will be no registration charge. Since accommodations will be limited, those who wish to attend are urged to register as soon as possible with Philips dealers or any North American Philips Co. office.

## Grants and Fellowships

Two new scholarship funds have been established at Ohio State University. A gift of $7500 from Mrs. Louise O. Caldwell and friends of the late **Frank C. Caldwell,** former professor of electrical engineering, established a memorial fund in his name and its income will be used for undergraduate scholarships in electrical engineering.

The **Dana J. Demorest** scholarship fund was set up by alumni gifts, totaling $3000, in honor of Dr. Demorest, now an emeritus professor. Income from this fund will support scholarships for students in metallurgical engineering.

Walter L. Nelson of Cornell University's department of biochemistry and nutrition has received a grant from **Swift and Co.** for study of the metabolism of mammary gland tissue.

The engineering honor society, **Tau Beta Pi Association,** has awarded the following graduate fellowships for 1954–55.

J. Tults, Purdue University. Electronics.
R. F. Hoglund, Northwestern Technological Institute. Heat power.
A. R. Chamberlain, Colorado A. & M. College. Fluid mechanics.
P. L. McCarty, Massachusetts Institute of Technology. Sanitary engineering.
S. J. Poulos, Massachusetts Institute of Technology. Design and construction of hydraulic structures.
L. D. Wall, Mississippi State College. Power systems.

**Tuskegee Institute** has been awarded a $3000 research grant by the **Upjohn Co.** for continuation of a project

for research on synthesis of drugs. Principal scientist is L. F. Cason.

A total of $454,596 in grants for research or professional training has been approved by **United Cerebral Palsy,** New York. A sum of $284,638 was allocated to basic and applied research in the medical field; $144,993 to training personnel; and $24,965 to projects in special education.

St. Christopher's Hospital for Children, Philadelphia. J. B. Arey. Diagnostic service for neuropathologic studies of cerebral palsy, $7500.

Children's Medical Center, Boston. B. B. Geren. Structure of the neuron, $7500.

Harvard University. P. I. Yakovlev. Developmental pathoarchitectonics of the central nervous system in congenital, heredo-familial and early acquired encephalopathies, $15,351.12.

University of Arkansas. W. K. Jordan, School of Medicine. Nucleic acid metabolism in growth and development of the central nervous system, $7992.

New York State Psychiatric Institute. H. Waelsch. Formation of proteins and enzymes in the developing central nervous system, $10,800.

Washington University. D. E. Smith. Evaluation of postmortem material for the study of the quantitative histochemistry of the human nervous system, $6,463.50.

Columbia University. E. A. Kabat, College of Physicians and Surgeons. Immunochemical studies of cerebrospinal fluid protein constituents in various neurological diseases and on mechanisms of allergic reactions, $10,746.

University of Utah. R. W. Doty. Visuo-motor behavior following damage to central nervous system; role of movement in learning, $16,470.

University of California. E. Eldred, School of Medicine. Centroneural control of the muscle spindle, $10,000.

Instituto N. de Cardiologia, Mexico City. A. Rosenblueth. Control of muscular activity, mainly the role of the central nervous system, $5000.

Montefiore Hospital, Pittsburgh. Y. D. Koskoff and R. A. Patton. Behavioral effects of hemispherectomy in primates previously submitted to brain damage, $16,038.

University of Cincinnati. G. H. Acheson, College of Medicine. Changes in ganglionic transmission resulting from section of postganglionic axons, $9000.

Boston University. A. M. Lassek, School of Medicine. Irreversibility of motor deficits following bilateral cerebral lesions, $8056.80.

Columbia University. J. B. Campbell, College of Physicians and Surgeons. Innervation of the urinary tract from the urethra to the renal pelvis in animals, directed at improving the therapeutic approaches to urinary dysfunction of neurogenic origin in man, $10,800.

Georgetown University. J. F. Fazekas. Influence of reduction of mean arterial pressure and of traumatic head injuries on cerebral hemodynamics and metabolism, $6048.

Children's Hospital of Philadelphia. C. Kennedy. Brain circulation in children with cerebral palsy, $14,806.80.

Georgetown University. E. Anderson, W. Haymaker, W. T. Spence, and D. M. Rioch, School of Medicine. Effect of brain lesions on endocrine function and metabolism, $11,793.60.

New England Deaconess Hospital, Boston. S. P. Hicks. Mechanisms of malformation, $7744.

Harvard School of Public Health. T. H. Ingalls. Experimental and epidemiologic investigation of congenital malformations of the central nervous system, $11,314.

Columbia University. C. M. Steer, College of Physicians and Surgeons. Pregnancy wastage with special reference to cerebral palsy as a result of blood group incompatibility, $11,646.72.

Columbia University. A. Wolf, College of Physicians and Surgeons. Etiology of functional and morphological abnormalities of the nervous system of the child. Inapparent maternal viral infection and damage to the fetal nervous system, $7,192.80.

University of California. J. M. Adams, D. Imagawa, and M. H. Jones. Placental transmission of viral infections, $17,354.

State University of New York. P. Gruenwald, Research Foundation. Physiology and pathology of aeration of the lungs of newborn infants, and of methods for the prevention of prolonged asphyxia at birth, $5769.

Johns Hopkins University. G. W. Corner, Jr., and G. W. Anderson, School of Medicine. Chemical and physiologic environment in fetal and neonatal anoxia correlated with the morphology of the brain, $9807.48.

University of Michigan. B. C. Graham and M. U. Tsao. Plasma oxygen tension in infants, $6000.

University of Utah. J. F. Bosma. Impairment of coordination of the mouth and pharynx in infants and children having cerebral palsy, $5994.

Children's Medical Center, Boston. B. Crothers. Natural history of cerebral palsy and film project, $10,000.

University of Illinois. S. A. Kirk. Language process of preschool cerebral palsied children, $13,085.28.

Syracuse University. G. O. Johnson, School of Education. Comparative study of attitudes of cerebral palsied children towards school, $11,880.

Orthopaedic Hospital, Los Angeles. R. Harrington, Breathing movements in a selected cerebral palsy population, $3517.56.

University of Michigan. E. F. Domino. Effects of antispastic drugs on brain stem mechanisms, $6372.

Children's Hospital, Boston. W. T. Green. Analysis of the value of surgical procedures in the treatment of cerebral palsy of the spastic type, $7560.

*Training grants*

American Physical Therapy Association. Training of physical therapists, $15,000.

American Occupational Therapy Association. Training of occupational therapists and pediatric neurologists, $25,000.

Educational summer workshops: University of Texas, $7000; University of Nebraska, $7920; Western Reserve University, $5400; Boston University, $1500.

Vocational summer workshops: University of Kentucky, $5000; Boston University, $3500; Pennsylvania State University, $800; Temple University, $5000.

Children's Rehabilitation Institute. Training of doctors and therapists, $10,000.

William Berenberg, Children's Medical Center, Boston. Program of clinical research and training in a demonstration cerebral palsy unit of the Children's Medical Center, $9000.

Columbia University School of Dental and Oral Surgery. Fellowship program for dental hygienists in dentistry for the cerebral palsied child, $4645.

Columbia University School of Dental and Oral Surgery. Fellowship program in dentistry for cerebral palsied, $15,860.

Columbia University College of Physicians and Surgeons. Postgraduate courses in cerebral palsy for physical and occupational therapists and physicians, $8000.

Luigi Luzzatti, Children's Hospital, San Francisco. Training program for personnel concerned with the care and treatment of the cerebral palsied pre-school child, $21,368.

The **University of Texas Medical Branch** has announced the establishment of the **James W. McLaughlin Fellowship Fund,** as a result of a generous bequest of the late A. C. McLaughlin of California. The fund honors a former professor of internal medicine at the Medical Branch, who was also a regent of the university. On recommendation of a special committee, the McLaughlin fellowships are to be used for the investigation of infection and immunity. Funds are available to support predoctoral and postdoctoral fellowships, as well as senior and faculty fellowships. Fellowships will be made available for 1 yr with opportunity for renewal in certain instances. Address application to the Executive Director, University of Texas Medical Branch, Galveston.

## In the Laboratories

**Arthur D. Little, Inc.,** has announced acquisition of the research and development division and laboratories of the Merrill Company, a metallurgy and engineering firm in San Francisco. The new unit is to be known as Little's Western Laboratories Division.

The first contribution by an industrial firm toward the creation of a bust of Josiah Willard Gibbs for

New York University's Hall of Fame has been received from the **M. W. Kellogg Co.** of New York. Arthur B. Kemper of Manhattan College, secretary of the American Chemical Society's New York section, is receiver of gifts for the fund. Checks payable to the section should be mailed to him at Riverdale 71, N.Y.

Effective 1 July, the **National Lead Co.** has been selected to operate the U.S. Atomic Energy Commission's Raw Materials Development Laboratory at Winchester, Mass., which has been operated by the **American Cyanamid Co.** under Commission contract since 1951. The laboratory is principally concerned with the development of processes for treatment of uranium-bearing ores in the production of uranium concentrates.

A $2,000,000 electronics laboratory has been opened officially by **Raytheon Manufacturing Co.** The U.S. Navy began construction of the building late in 1952, when it was planned that Raytheon would use the structure as a Navy research and development center. It is one of the most advanced of all laboratories for the development of aircraft electronics equipment and guided missiles control systems. It has 100,000 $ft^2$ of floor space on two floors, and can house approximately 700 workers. There are 21 specially designed bays for operating and testing radar equipment.

For "pioneering use of television in bettering the health of the nation," the American Medical Association recently awarded a special citation to the Philadelphia Pharmaceutical house, **Smith, Kline, & French Laboratories.**

The **Westinghouse alternating current network calculator** was set into operation on 1 July at an official opening. Built by the Westinghouse Corp. and cooperatively sponsored by seven major power companies, the calculator is housed in The Franklin Institute Laboratories for Research and Development. The sponsoring power companies—Atlantic City Electric Co., Delaware Power and Light Co., Jersey Central Power and Light Co., Metropolitan Edison Co., New Jersey Power and Light Co., Pennsylvania Electric Co., and Philadelphia Electric Co.—will use this $400,000 analyzing device to stimulate conditions of their respective electric power systems. The participants will contribute to operating costs in proportion to their annual work load. Should companies not require all their allotted time, they are free to relinquish a portion of it to other nonsupporting utilities.

## Miscellaneous

The first two issues of the *ASB Bulletin*, the new quarterly publication of the Association of Southeastern Biologists, have been circulated. Both, one for March and one for June, contain articles on the editorial plans of the publication. At present research papers are not included, but it is possible that a section devoted to short papers may be added after several years. The new bulletin will run about 64 pages per volume. The subscription rate is $2.00 per year. For further information write the editor, V. A. Greulach, University of North Carolina, Chapel Hill, N. C.

A *Directory of Geologists and Exploration Geophysicists* belonging to the member societies of the American Geological Institute was issued by the Institute in April. Approximately 20,000 names and addresses are listed in the directory, which is a by-product of the work on the Earth Sciences Section of the National Register of Scientific and Technical Personnel carried out by the Institute in cooperation with the National Science Foundation. The directory is mimeographed and sells for $2.50 in the United States, Canada and Mexico.

The Society of Actuaries has just published a 300-page report on an extensive investigation of the mortality experienced among insured lives with various physical impairments. Entitled *1951 Impairment Study*, it is the latest in a series of medico-actuarial investigations conducted in this country over the last 45 yr by actuaries and medical men. The present study represents in effect the experience between 1935 and 1950 connected with some 725,000 policies that were followed up for varying periods of time up to 15 yr, with over 18,000 deaths among them. More than 130 groups of different impairments were included in the study.

By act of Congress, Mar. 3, 1847, an appropriation was granted to Henry Rowe Schoolcraft, explorer and historian, and he was authorized to prepare what presumably would be a complete and definitive encyclopedia on American Indians and everything pertaining to them. The project was to be carried out under the direction of the Office of Indian Affairs. The first volume of Schoolcraft's *Historical and Statistical Information respecting the History, Condition and Prospects of the Indian Tribes of the United States* appeared in 1851. Five others followed.

Preparation of this opus had involved an enormous amount of work in the collection of data, but the material was poorly organized. Many of Schoolcraft's philosophical and ethnological ideas, which he stressed, long since have become outmoded. Sometimes his facts were quite mixed up. Nevertheless, the work represents an almost unequaled wealth of material that has been an invaluable source of information for historians and ethnologists. The record is of particular significance because the data, however wrong at times, came from intelligent observers who were in personal contact with the Indians before their ways of life had been much affected by white contacts. The first comprehensive **index to Schoolcraft's volumes**, which will make the work more generally useful to scholars, has just been issued by the Smithsonian Institution's Bureau of American Ethnology. It was prepared, during several years of intensive work, by Frances S. Nichols, formerly of the Bureau staff.

# *Book Reviews*

***Antiseptics, Disinfectants, Fungicides, and Chemical and Physical Sterilization.*** George F. Reddish, Ed. Lea & Febiger, Philadelphia, 1954. 841 pp. Illus. $15.

This new treatment of antimicrobial agents appears as a worthy successor to McCulloch's *Disinfection and Sterilization.* Like its predecessor from the same publisher, Reddish's book should become a standard and useful reference in its field.

The scope of the book is indicated by its eight parts: introduction; methods of testing; antiseptics; disinfectants, fungistats and fungicides; preservatives; chemical and physical sterilization; and pasteurization. "The grouping of the chapters in their respective categories," prefaces the editor, "has been somewhat of a problem." Thus, the part on antiseptics is subdivided on the bases of both chemical families (mercurials, alcohols, and so forth) and uses (surgical antiseptics, antiseptic powders, virucidal agents, and so forth). However, the major established subject areas that have been selected, exclusive of antibiotics and other chemotherapeutic drugs, are well covered. A separate chapter is accorded sterilization by ionizing radiation, although nonionizing radiation, sonic oscillation, desiccation, pressure, and other developmental or minimally important areas are relatively neglected.

The 30 contributors, one half from commercial organizations, give the diversified subject matter an authoritative treatment unattainable by a single author. The prefaced promise and excellent example in text of the editor for "interpretations and evaluations of the subject matter by each contributor" unfortunately are not always followed, and several chapters are preponderantly documentary.

The inclusion of comprehensive treatment of terminology and methodology should lead toward standardization where it is sorely needed. General agreement on definition of terms, not only by the 30 representative contributors, but also by several leading organizations to which the chapter was submitted prior to publication, should go far toward dispelling the vagueness and varied use that have clouded such words as *antiseptic.* Pertinent methods of testing are presented in detail and are evaluated. The phenol coefficient test receives deserved but fair criticism: "impractical and unscientific" for nonphenolic disinfectants, "meaningless" for skin antiseptics, but "still satisfactory for the testing of phenol–like compounds for use on inanimate objects."

The book is organized, and should find its greatest usefulness, as a handbook for practical application of antimicrobial agents. For this there is a very definite need. To the reviewer, however, it falls short in not interpreting, either critically or comprehensively, the physiological action of these agents. But one short chapter is devoted specifically to theory and this primarily to consideration of the genetic basis of resistance. Some chapters (for example, phenolics) fail entirely to consider mechanism of action and others do so superficially. Even the chapter on thermal resistance of microorganisms is devoted primarily to quantitation of death and dismisses basic mechanism of hydrothermal death in a short paragraph. In these respects, the science of the subject has given way to technology.

PHILIPP GERHARDT

*Department of Bacteriology*
*University of Michigan Medical School*

***The Chemical Structure of Proteins.*** Ciba Foundation Symposium. G. E. W. Wolstenholme and Margaret P. Cameron, Eds. Little, Brown, Boston, 1954. xii + 222 pp. Illus. + plates. $6.

This book includes the papers and verbatim records of questions and discussions that ensued at a symposium held 1–3 Dec. 1952. The report is a mine of practical information for anyone concerned with the actual operations of research on its subject. This results from the very practical level of presentation and discussion. The subjects discussed include methods of fractionation for proteins, amino acids, and peptides; C-terminal and N-terminal amino acids; methods of cleavage of peptide chains (chemical and enzymatic); acyl migrations within a peptide chain; the peptides of tissues as well as those derived from proteins by partial hydrolysis; the structure of protamines and the relationship of electron optical and chemical studies of collagen.

The difficulties and disappointments that have come to the reporters appear along with the triumphs. Pathways with no visible outlet are explored for some distance, and some of the obstacles to progress are assayed. The participants obviously were delighted to have arrived at the same point along different paths and were at a loss to understand why this meeting did not always occur.

The 16 formal papers range from 4 to 17 pages, and the discussion records occupy 2 to 4 pages each. The papers are simple in form and are as easily read as any collection on this subject. The presentation is quite topical, for practically every author emphasizes as much of what he hopes to do (and has by now attempted) as what has been done.

The permanent value of the publication is likely to be inspirational rather than definitive, for it tells the story of developing method and understanding. It is regrettable that 15 months were needed to bring the report through the press. Editing and manufacture are well done, but perhaps a less costly form would have been appropriate to insure a wider distribution among those who would benefit most from owning the book.

MILTON LEVY

*Department of Biochemistry,*
*New York University College of Medicine*

***Contributions to the Theory of Riemann Surfaces.*** L. Ahlfors *et al.*, Eds. Princeton Univ. Press, Princeton, N. J., 1953. 264 pp. $4.

A hundred years ago Bernhard Riemann wrote his famous and fundamental doctoral thesis *Grundlagen für eine allgemeine Theorie der Functionen einer veränderlichen complexen Grösse,* in which he created the geometric function theory and, in particular, introduced the concept of "Riemann surfaces." In order to celebrate this centennial anniversary, a Conference on Riemann Surfaces was held at Princeton, 14–15 Dec. 1951. On this occasion 21 well-known mathematicians presented papers that showed the great and inspiring influence of Riemann's ideas to the development of modern mathematics.

An introductory article by L. V. Ahlfors gives a very interesting historical review on the 100 years of the theory of conformal mapping and Riemann surfaces up to our present time. The wide range of the more special contributions of the other mathematicians is very remarkable. They discuss variational methods (M. Schiffer), topological methods (J. A. Jenkins and M. Morse), Dirichlet's principle (Z. Nehari, M. Schiffman), conformal mappings (J. A. Jenkins, A. C. Schaeffer, S. E. Warschawski), studies of Riemann surfaces under many different points of views (E. Calabi, L. Fourès, M. Heins, S. Kakutani, W. Kaplan, P. C. Rosenbloom, H. L. Royden), structure of complex spaces (S. Bochner), functions on Riemann surfaces (L. Bers, L. Sario), linear partial differential equations (S. Bergman), operators on manifolds (D. C. Spencer), and the Riemann-Roch theorem (K. Kodaira). These many diversified contributions show that the interest in these questions is at present alive and strong.

ARTHUR ROSENTHAL
*Department of Mathematics, Purdue University*

***Notions Elémentaires de Chimie Générale.*** Paul Pascal, Masson, Paris, 1953. 550 pp. Illus. + plates. 3600 fr.

During 1949–52 Paul Pascal published four volumes, totaling 1800 pages and constituting "an exposition, theoretical and critical, of the principal problems of Physical Chemistry that should be known to every trained chemist."

The present volume is a selection of themes and topics from this exhaustive treatise and is a summary for the reader who cannot afford the time or does not have the mathematical training to master the definitive work. It is designed specifically for premedical and biology students. It is not so much concerned with "general" or descriptive chemistry, as we would use the terms, but rather with classical physical, including colloid, chemistry.

To compensate for his selectivity of coverage and for his abridgment of full mathematical treatment, the author has included many diagrams and models designed to aid comprehension of the text. Also, "thanks to the relative independence of the principal chapters, a reader stopped by a momentary difficulty can 'jump,' during a first reading, without risk of losing the sequence of the development." Another useful feature is a chapter on the reading of graphs.

The main chapter headings are "Evolution of ideas on the nature of matter"; "Lacunal and discontinuous structure of things"; "Structure of the material atom"; "Modification of the nuclear structure"; "Molecular and ionic structures"; "Macrostructures"; "Mechanism of grouping of atoms and ions"; "Chemical kinetics"; "Evolution and equilibrium of chemical systems"; "Graphical representation of systems"; "Particulate study of liquid solutions"; "Surface phenomena"; and "Disperse systems."

The literary style is direct, and the American reader with a moderate facility in technical French will have no difficulty. This book could profitably be read not only by students but also by mature professionals in the collateral sciences, particularly the biological. I know of no entirely comparable work in English.

BEVERLY L. CLARKE
*Chemical Division, Merck & Co., Inc.*
*Rahway, New Jersey*

***Handbook of Freshwater Fishery Biology with the First Supplement.*** Kenneth D. Carlander. Brown, Dubuque, Iowa, 1953. v + 429 pp. $6.50 (Owners of the *Handbook,* 1950, may purchase the supplement, separately bound, for $3.)

Various branches of science not richly endowed with funds for bibliographic syntheses are sometimes blessed with a scholar of classical unselfishness. Fisheries is currently such a field, and Kenneth Carlander is such a scholar. It was my pleasure to review [*Science* **113,** 458 (1951)] this author's first source book of age, growth, and life-history data on American food, game, and other fishes. The supplement extends and brings more nearly up to date the published information on the subjects covered. Its outstanding feature is the expanded section on population data. This part composed less than 5 percent of the original work but makes up more than 10 percent of the supplement. It adds about 450 titles to the original number of some 1100 which were abstracted earlier. The summary is indicative of a tremendous investment on the part of American workers in descriptive studies of growth in length and weight. It makes one wish that proportional effort had been spent on the how and why of fish growth

Subdivision of the topic "Population data" in the table of contents for both original and supplement would have helped me and, more importantly, the user.

One cannot peruse a compilation such as Carlander's without regretting that so much additional information, of the kind reported, is not generally available for inclusion. Examples of such data are in the countless unpublished reports that lie in the files of state, federal, and private fishery agencies and in the many unprinted collegiate theses. It would seem desirable that fishery workers generally adopt an active pro-

gram of bringing such material into Carlander's hands. This would be particularly true of material for which other publication is unlikely or uncertain.

It is common knowledge in other fields that through use informational source books tend to become biblical in stature. Fishery workers will do well to guard against such an eventuality by strict avoidance of the unscientific practice of unduly substituting data from Carlander for direct use of original papers. In order to avoid perpetuation of inadvertencies, which almost necessarily are a part of any compendium, it is to be hoped that originals will continue to be used faithfully in spite of the convenience of this handbook. Let the handbook be the key to the literature, but do not let it become the oracle!

Dr. Carlander deserves the continuing praise and gratitude of his colleagues in aquatic biology and fisheries. He certainly has mine.

KARL F. LAGLER

*Department of Fisheries,*
*School of Natural Resources, University of Michigan*

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# New Books

***Theory and Method in the Social Sciences.*** Arnold M. Rose. Univ. of Minnesota Press, Minneapolis, 1954. xii + 351 pp. $5.

***Introduction to the Chemistry of Enzymes.*** Keith J. Laidler. McGraw-Hill, New York–London, 1954. ix + 208 pp. Illus. $5.

***Introduction to Nuclear Engineering.*** Raymond L. Murray. Prentice-Hall, New York, 1954. xiii + 418 pp. Illus. $7.

***So Little for the Mind.*** ed. 2. Hilda Neatby. Clarke, Irwin, Toronto, 1953. xiii + 384 pp. $3.

***Tables of Integral Transforms.*** vol. I. Based, in part, on notes left by Harry Bateman. Bateman Project Staff, A. Erdelyi, Ed. McGraw-Hill, New York–London, 1954. xx + 391 pp. $7.50.

***Principles of Biology.*** W. Gordon Whaley *et al.* Harper, New York, 1954. ix + 694 pp. Illus. $6.

***Rocks and Mineral Deposits.*** Paul Niggli; trans. by Robert L. Parker. W. H. Freeman, San Francisco, 1954. xiii + 559 pp. Illus. $12.

***Optical Instrumentation.*** George S. Monk and W. H. McCorkle, Eds. McGraw-Hill, New York–London, 1954 xxv + 262 pp. Illus. $3.75.

***Nobel Prize Winners in Chemistry: 1901–1950.*** Eduard Farber. Schuman, New York, 1953. x + 219 pp. Plates. $5.

***Truk: Man in Paradise.*** Viking Fund Publications in Anthropology, No. 20. Thomas Gladwin and Seymour B. Sarason. Wenner-Gren Fdn., New York, 1953. 651 pp. Illus. + plates. $6.50.

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***Minnesota's Rocks and Waters.*** A geological story. George M. Schwartz and George A. Thiel. Univ. of Minnesota Press, Minneapolis, 1954. xviii + 366 pp. Illus. $4.

***Essays on the Social History of Science.*** S. Lilley, Ed. Munksgaard, Copenhagen, 1953. 182 pp. Paper, 30 kr.

***Time Counts.*** The story of the calendar. Harold Watkins. Philosophical Library, New York, 1954. vi + 274 pp. Illus. + plates. $3.75.

***Methods of Research.*** Educational, psychological, sociological. Carter V. Good and Douglas E. Scates. Appleton-Century-Crofts, New York, 1954. xx + 920 pp. $6.

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# *Technical Papers*

## Theoretical Foundations of Audio-Visual-Tactile Rhythm Induction Therapy Experiments

Theodore C. Kahn*

*University of Southern California, Los Angeles*

An instrument has been assembled in a college electronic laboratory (*1*) that is designed to emit audible clicks in rhythmic acoustic patterns, light flickers that are variable in speed and intensity and are adapted with a color selector, and tap hammers that make distinct but painless cutaneous rhythmic contacts. The clicks, light flickers, and taps have rhythmic patterns that are separately variable. The subject controls this variability by manipulating dials. The range of the audio, visual, and tactile impulses vary from 1 impulse/3 sec to the critical frequency at the threshold of incapacity to distinguish pulsation. The latter differs for each of the three types of sensory stimuli.

Three revolving drums are electrically attached to the instrument, making it possible to obtain continuous recordings of the various frequencies selected by the subject for each element.

Experiments to be conducted with this device are of two kinds. The possibility that the instrument may be diagnostic will be explored. The optimum rhythm patterns (most pleasant to listen to, look at, and feel) will be determined for neurotics, various categories of psychotics, psychopathic deviates, and nonpsychotics. A variety of rhythm patterns will be investigated using these populations. Psychogalvanometric and other physiological data will be recorded simultaneously by means of a multichannel polygraph.

The other research will be concerned with a possible psychiatric and somatic therapeutic effect of exposure over a period of time to a variety of rhythms and the achievement of conditioned tolerances to irritating frequencies.

Electroencephalographic responses of psychic states during rhythmic acoustic patterns produced by variations of metronome clicks have already been investigated in experiments at Tohoku, Japan (*2*), and a highly positive relationship was found to exist between subjective and EEG responses to the several experimental situations. Gengerelli (*3*), using remote-control electric stimulation of the cortex of rats, found that variations in rhythms caused characteristically differentiating behavior when strength and direction of charge remained constant.

O'Flanagan, Smith, and Taylor (*4*) used 20 subjects in a photic rhythm stimulation experiment; with the aid of a stroboscope, they were able to obtain powerful reactions of sympathetic neural centers short of full photogenic seizures. Libet and Gerard (*5*) have demonstrated the rhythmical character of neuromuscular activity by using action potential records from an isolated mass of cortical tissue. Freeman (*6*) states that the "rhythmical character of excitability suggests a primordial basis for neuromuscular homeostasis."

These and other studies suggest that neuromuscular activity may be stimulated and behavioral modifications accomplished through rhythmic sensory stimulations. The present theory postulates the therapeutic implications through controlled conditioning by multiple-sensory stimulation. It is predicated on the possibility, as yet unexplored, that the interaction of specific frequencies (to be determined) may leave residuals beneficial to the somatic and psychological integrative processes of an individual.

Music, dancing, and rhythmic manual work have been used therapeutically with varying success. The physiological rhythm responses to tissue impairment, the dysrhythmia of the neural electric field that characterizes cortical damage, and the diastolic, systolic, respiratory, and circulatory rhythms are seen as having integrative neuromuscular counterparts of a Gestalt nature apart from organ function and neural reinforcement of the learning theory. Rhythm induction therapy would modify this configurational field by exposing the patient over a period of time to the interplay of specific series of audio, visual, and tactile frequencies. It has already been demonstrated by Gengerelli (*7*) that variations of rhythm patterns stimulate differential behavior in mice and that these rhythms can be emitted and regulated by remote control. The research of Miller *et al.* (*8*) indicates the compelling nature of subliminal clues in behavioral modfications.

The hypothesis that behavioral and personality changes may be accomplished subliminally by electronic, remote-control methods is a valid one. The two recent articles by Faukhauser (*9*) give the theory of emotional alterations of masses of population by subliminal, rhythmic remote-control techniques added plausibility. This is particularly interesting inasmuch as the instrument described here has already demonstrated its capacity for stimulating, in a relatively short time, a hypnotic-type stupor in several experimentally tested subjects.

A paranoid schizophrenic patient was asked to describe his feelings while being subjected to the rhythm pattern he had selected. He stated: "I can find a definite rhythm here that does not seem to be disturbing to thought continuity. I find myself thinking of driving across a level terrain watching a beacon of light. Also it suggests flying the beam by radio control. I find no hostility in this rhythm." He asked for a piece of paper, saying, "I just want to chart the thing to see whether the content is the same." Three other patients reacted to the number of selected rhythms by showing considerably greater likes and dislikes of certain frequencies than a group of five nonpatients. Two

* At present on active duty in the Department of Psychology, School of Aviation Medicine, USAF, Randolph Air Force Base, Texas. (Nothing in this article reflects official Air Force opinion.)

obsessive-compulsives showed characteristic behavior in spending a considerably longer time in the selection of "pleasing" rhythms than members of other groups. These experiments were not intended to demonstrate that this method is capable of discriminating between clinical groups. However, the indications are that further research is justified on the basis of the interesting responses to audio-visual-tactile stimulation.


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## Ionic Permeability and Osmotic Swelling of Cells


**T. H. Wilson**

*Department of Physiology,*
*University of Pennsylvania Medical School, Philadelphia*
and *Department of Biochemistry,*
*Army Medical Service Graduate School,*
*Walter Reed Army Medical Center, Washington 12, D.C.*


Many mammalian tissues when studied under unnatural conditions outside the body have been observed to swell in salt solutions isosmotic with blood and tissue fluids. One suggested explanation of this behavior is that the contents of the cells of these tissues *in vivo* are hypertonic to the surrounding media and the water that tends to enter them by osmosis is normally removed by a process of active water secretion (*1*). When this process fails because of anaerobic conditions, the action of metabolic poisons, or low temperature, the cell swells.

Little is definitely known at present about mechanisms, other than contractile vacuoles, for primary active transport of water, but much information has recently been gained concerning processes of active ionic transport in a great variety of cells. Such processes are known to be frequently accompanied by passive osmotic movement of water—for example, the movement of water associated with secretion of NaCl by a frog's skin (*2*).

The influence of colloid osmotic pressure on the movements of ions and water is well accepted in the case of capillary walls, but it is not generally recognized in the case of most tissue cells. A known instance in which this is involved is the type of hemolysis that Wilbrandt (*3*) calls "colloid-osmotic." Jacobs and Stewart (*4*) have discussed in some detail the osmotic consequences of a variety of types of ionic and molecular permeability, including the abnormally high cation permeability of the erythrocyte that gives rise to hemolysis by swelling. A very convenient agent for producing different easily controlled degrees of cation permeability and of swelling in salt solution is n-butyl alcohol (*5, 6*).

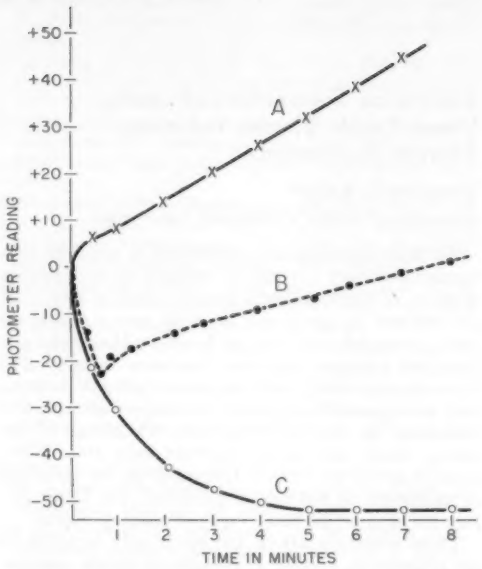


Fig. 1. Volume changes of butyl alcohol-treated beef lymphocytes in various isosmotic solutions. Beef lymphocytes were placed in a mixture of 1 part 0.3*M* sucrose and 5 parts 0.15*M* NaCl (*p*H adjusted to 7.4 with phosphate buffer) containing 5 vol percent n-butyl alcohol. After exposure for 5 min, the cells were diluted five fold with the same sucrose-NaCl mixture without butyl alcohol. One milliliter of the treated cell suspension was added to 10 ml of the following solutions: (A) 0.15*M* NaCl; (B) 1 part 0.3*M* sucrose and 5 parts 0.15*M* NaCl; at zero time 3 drops of saturated NaCl solution was added; (C) 0.3*M* sucrose. Similar results were obtained with polymorphonuclear leucocytes from rabbits.

The erythrocyte is a highly specialized cell whose behavior may or may not throw light on the mechanism of volume changes in typical mammalian tissue cells. Experiments were, therefore, made with leucocytes, whose general properties are more closely related to other animal cells. Polymorphonuclear leucocytes were prepared from rabbits by lavage of the peritoneal cavity with saline. A mixture of lymphocytes, monocytes, macrophages, and erythrocytes was also prepared from spleen by mincing the tissue suspended in isosmotic $NH_4Cl$. Erythrocytes were hemolyzed in this solution, leaving intact the leucocytes, which were then centrifuged and resuspended in buffered saline. Volume changes of these cells were measured by changes in optical density in a sensitive photometer.

The result of one experiment is shown in Fig. 1. Following treatment with butyl alcohol, the leucocytes maintain their normal volumes for a long time in a mixture of 1 part isosmotic sucrose and 5 parts isosmotic saline; but the cells swell rapidly in isosmotic NaCl solution alone, shrink rapidly in isosmotic sucrose solution alone, and shrink with rapidity and then less rapidly recover, or slightly surpass, their original volume when a little concentrated NaCl is added to the surrounding medium. Shrinkage of cells in isosmotic sucrose is due to the diffusion of salt out of the cells followed by a movement of water. Such cells have enormously increased permeability to anions, as well as to cations, but retain their normal impermeability to sucrose and protein. These results illustrate an essential agreement in the behavior of leucocytes and erythrocytes.

It should be remembered that, although an active transport of cations is essential to the continued existence of the erythrocyte, its absence would be expected to produce swelling only very slowly. It is now known that the physical permeability of this cell to cations is so low that, despite its extremely favorable surface-volume relationship, rates of exchange of potassium across the surface of the human erythrocyte at body temperature are less than 2 percent of the cell potassium per hour (*7, 8*). By way of contrast, Davies and Galston (*9*) have reported for kidney cells exchanges of the order of 15 percent per minute. It follows, therefore, that, while a considerable degree of surface injury by butyl alcohol or other agents is needed to produce rapid swelling of the erythrocyte, a mere cessation of the normal ionic transport process might soon bring about the same result in the kidney cells.

Perhaps the strongest reason at present for believing that ionic movements may be involved in the volume changes of tissue cells outside the body is the recent observation by Deyrup (*10*) that, while kidney slices swell in solutions of NaCl or monosaccharides isosmotic with blood, they shrink in similar solutions of disaccharides. This behavior, which strongly resembles that of the erythrocyte and the leucocyte after treatment with butyl alcohol, cannot be explained by a simple initial hypertonicity of the cells themselves. Preliminary evidence has also been obtained that the mammalian intestine behaves in the same way. In six experiments, rat intestine increased in water content 17 percent over the control when placed in 0.15*M* NaCl at 0°C, increased 7.6 percent in a solution composed of 1 part 0.3*M* lactose and 5 parts 0.15*N* NaCl, and decreased 13.2 percent in a 0.3*M* lactose solution.

The data presented are consistent with the hypothesis that the tendency of salts and water to enter cells owing to the intracellular colloid osmotic pressure is, under normal conditions of oxygenation, temperature, and so forth, exactly balanced by the active transport of ions and passive movement of water out of the cell.

The valuable advice and criticism of M. H. Jacobs throughout the course of this work is gratefully acknowledged.

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12 February 1954.

## Ascomycete Spore Mutants and Their Use in Genetic Studies

**George Bistis and L. S. Olive**

*Department of Botany, Columbia University, New York*

*Ascobolus stercorarius* is a heterothallic ascomycete which in its life-cycle resembles in many ways the eight-spored species of *Neurospora*. In wild-type crosses of the two mating types, every fruiting body produces hundreds of asci, each of which contains eight haploid, uninucleate ascospores. These spores become purple, then brown, as they mature.

In the course of our genetic studies, two interesting cultures have been obtained, both of which appear to be single-gene mutants. The first of these carries a factor for ascospore abortion. Thus, in a cross between this mutant and a wild-type isolate, the resultant asci contain four viable, brown-colored spores and four abortive, colorless spores (Fig. 1). This particular mutation apparently occurs quite frequently in this species, and it has been found by at least two previous workers. Dowding (*1*) reported that in wild-type crosses many of the asci contained these two types of spores. Ingold (*2*) pictures a fruiting body of *A. stercorarius* showing an ascus with these two spore types.

The second mutant apparently carries a factor influencing only spore color. When it is crossed with a wild-type strain of appropriate mating type, the asci produced contain four wild-type, brown-colored spores and four mutant, tan-colored spores (Fig. 2). In this case, however, all eight spores are viable. In the case of both mutants, crosses with wild-type cultures always produce the six expected ascus segregation patterns, and a preliminary scoring of asci gives a second-division segregation frequency of approximately 20 percent for the spore abortion factor and about 62 percent for the tan-spored factor. Therefore, the two are not alleles, but whether they are linked has not yet been determined.

Figure 3 shows one type of ascus resulting from a cross between the two mutants. The spore abortion locus has segregated in the first division, while the tan-spored locus has segregated in the second. All of the four expected ascospore phenotypes cannot be distinguished, since the four spores carrying the abor-

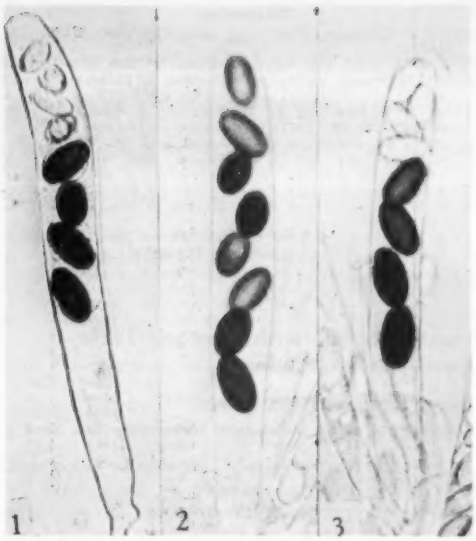


Fig. 1. Ascus showing first-division segregation of the spore abortion factor. Fig. 2. Ascus showing second-division segregation of the tan-spored factor. Fig. 3. Ascus resulting from a cross involving the two mutant strains. (×500)

tion factor are phenotypically alike regardless of whether they carry the wild-type or mutant factor at the tan-spored locus.

The use of this organism in genetic studies affords certain definite advantages. It is easily cultured in Petri dishes containing an agar medium of yeast extract and cellulose (*3*). The time required for one generation to mature is between 10 and 14 days. A single plate of paired cultures forms many fruiting bodies, each of which contains hundreds of asci. Since these asci can be scored merely by direct examination, the results of 500 meioses have been counted in one 3-hr period. Another advantage of this method is that the autonomous effects of single genes upon single haploid cells (the ascospores) may be observed without the complications of dominance and recessiveness. Furthermore, the ascospore pattern in each ascus is a visual and orderly replica of meiosis and, as such, is a valuable aid in the study of segregation and crossing over, eliminating the necessity for laborious ascus dissection. It is obvious from the evidence obtained with the use of these mutants that brachymeiosis does not occur in *A. stercorarius*.

A fuller presentation of these data will be published in the near future.

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## Oak Wilt Fungus Labeled with $C^{14}$

Paul F. Hoffman and Bert M. Zuckerman

*Section of Applied Botany and Plant Pathology, Illinois State Natural History Survey, Urbana*

Since the fungus *Endoconidiophora fagacearum* Bretz, causal agent of oak wilt, lives parasitically only in the woody conducting tissues under the bark of a diseased tree, its progress from a point of infection to distant parts of a tree can be traced only with laborious difficulty The fungus produces, when grown *in vitro*, a toxic substance that is capable of causing tomato and oak cuttings to wilt. Tagging either the fungus, as has been done by Wheeler (*1, 2*) with other fungi, or the toxic substance with a radioactive element, without altering the pathogenicity of the fungus or the nature of the toxin, would afford better opportunity to study the disease experimentally (*3–5*).

Uniformly $C^{14}$-labeled sucrose (*6*) with a specific activity of 2.64 μc/mg was used in the preparation of 1- and 2-ml lots of a sucrose-asparagine-yeast extract medium (*7*) having activities of 10, 20, and 30 μc/ml, unlabeled sucrose being used to make up the 20-g/lit sucrose ratio in each lot. These lots, each in cotton-stopped, 10-ml Erlenmeyer-shaped flasks, were planted after sterilization with tiny wefts of mycelium and spores.

These cultures were then placed in moist chambers and incubated at 27° to 30°C. After having developed for periods of 7 to 56 days, the new mats of fungus were taken from the flasks, laid on filter paper, and washed with a stream of sterile water until no radioactivity (*8*) could be detected in the wash water. From the washed fungus, transplants were made to unlabeled agars in Petri dishes and allowed to develop into new colonies. Mycelium and spores from the peripheries of these colonies were used in subsequent tests.

Verification that the fungus had become labeled during its growth on the $C^{14}$-containing media was obtained by autoradiography. Bits of fungus taken from colony peripheries were placed on glass microscope slides in drops of water, in drops of unlabeled liquid medium, or on thinly spread potato dextrose agar and allowed to grow for periods of 36 to 144 hr. Also, to obtain closely appressed growth, transplants were made to DuPont 600 P. T. cellophane spread on potato dextrose, chestnut meal, and water agars in Petri dishes. Before autoradiographs were made, the fungus was killed by heat at 80°C and the preparations were dried for several hours over $P_2O_5$. Autoradiographs of these preparations were made on Eastman No-Screen X-ray emulsion and on several Ilford nuclear-track emulsions (*9*)—NTB2, NTC2, NTD1, NTE1, and NTG5—ranging from 25 μ to 200 μ in thickness.

Well-defined autoradiographs of germinated spores were obtained on NTG5 emulsion 100 μ, and of mycelium and spores on Eastman No-Screen X-ray emulsion (Fig. 1). The two most satisfactory methods of

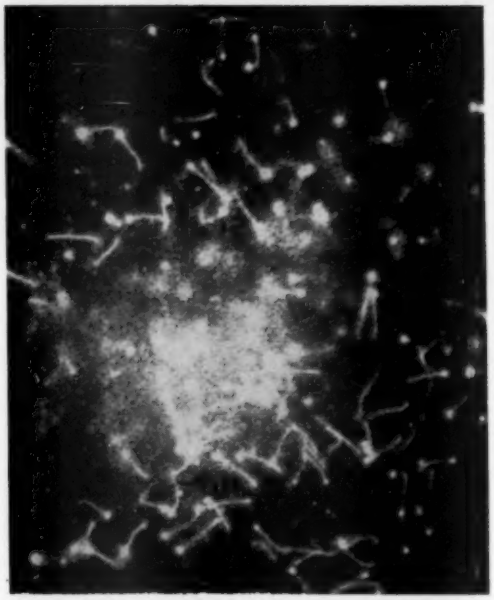

Fig. 1. Autoradiograph produced on Eastman No-Screen X-ray emulsion by germinated spores of *Endoconidiophora fagacearum* Bretz taken from a colony labeled with $C^{14}$. (×9.5)

preparation were to grow the fungus for periods of 24 to 48 hr in a drop of liquid medium on a glass slide and to grow it on cellophane spread over agar.

When planted on unlabeled agars in Petri dishes, the labeled fungus grew normally, even after it had been grown for 56 days on the 30-μc/ml medium. Macroscopically, colony characters were like those of the unlabeled parent; microscopically, measurements of 200 labeled and 200 unlabeled conidia revealed no significant differences between the two; and significant differences were not apparent in percentage of germination, rate of germination, and appearance after germination (Table 1).

In 3 days, a labeled strain of the fungus developed on the 30-μc/ml medium, and an unlabeled compatible strain, upon being crossed on unlabeled agar, produced perithecia and ascospores that were not different in any morphological character from perithecia and ascospores produced by unlabeled compatible strains. Exuded masses of ascospores lifted from the perithecial beaks contained detectable radioactivity when measured in a Q-gas scaler (*10*) and, upon being inoculated into red oak (*Quercus ruba* L.) seedlings in the greenhouse, produced typical wilt symptoms (*11*) in 47 days. It appears that transference of $C^{14}$ labeling into the ascospores occurred. Possibly, then, radioactive labeling may be useful also in studying the life-history and genetics of the fungus.

Injection of suspensions of labeled conidia into red oak and live oak (*Q. virginiana* Mill.) seedlings was followed by typical wilt symptoms 20 days after inoculation. With symptom-bearing leaves from seedlings of both kinds of oak, autoradiographs were obtained on Eastman No-Screen X-ray emulsion in 20 days. By monitor (*12*), no radioactivity in the stems of the seedlings could be detected through the bark, but at the ends of cut stems readings of 30 to 40 counts/min above background were obtained, and at upper and lower leaf surfaces readings of 20 to 30 counts/min above background were obtained.

When grown in the 20-μc/ml medium, the fungus produced a substance that caused wilting of both tomato and oak cuttings like the wilting caused by the substance which the fungus produces in unlabeled media. That the two substances were the same was indicated further by the fact that filtrates from both labeled and unlabeled cultures gave the same Rf value, that of an as yet unidentified organic acid, on paper chromatographs.

It is not known whether the radioactivity detected by autoradiograph in the leaves and by monitor in the stems and leaves of inoculated oak seedlings indicated the presence of the fungus, its toxin, or some other metabolite. But the experiments show that, within the activity range used, mycelium, conidia, and probably ascospores can be labeled with $C^{14}$ without altering the morphology or pathogenicity of the oak wilt fungus or changing the effect or nature of the toxin.

Work currently under way and planned for the future is concerned with more accurate determinations of the amount of labeling possessed by the fungus

Table 1. Germination at 23°C of unlabeled and $C^{14}$-labeled conidia of *Endoconidiophora fagacearum* Bretz of the surface of water agar.

| Petri dish | Spores | At 24 hr | | | At 36 hr | | |
|---|---|---|---|---|---|---|---|
| | | Number counted | Percentage germinated* | Secondary sporulation | Number counted | Percentage germinated* | Secondary sporulation |
| 1 | Unlabeled | 200 | 60.0 | None | 200 | 80.0 | By about 25% of all germinated spores in each dish |
| 2 | Unlabeled | 200 | 65.5 | None | 200 | 75.5 | |
| 3 | Labeled | 200 | 72.5 | By 1 germinated spore | 200 | 86.0 | |
| 4 | Labeled | 200 | 69.0 | None | 200 | 78.0 | |

* Differences are not significant at the 5-percent level.

spores, the manner in which ascospores become labeled, and the isolation and identification of exometabolites produced by labeled strains of the fungus.

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6. We are indebted to R. F. Nystrom, University of Illinois Radiocarbon Laboratory, for supplying the labeled sucrose and for technical advice.
7. Per liter: $KH_2PO_4$, 0.5 g; $MgSO_4 \cdot 7H_2O$, 0.25 g; asparagine, 1.0 g; yeast extract, 1.0 g; sucrose, 20.0 g; distilled water, q.s.
8. Dried drops of the last wash water failed to show evidence of radioactivity in autoradiographs after 30 days or more of exposure.
9. Robert A. Reitz, of the University of Illinois Betatron Laboratory, supplied the emulsions and developed certain autoradiographs.
10. The average differences above background of the counts obtained with ascospore masses indicated odds of 9 : 1 that the difference was not due to chance alone.
11. The oak wilt fungus was reisolated from seedlings inoculated with labeled ascospores and conidia; but, probably because of attenuation of the labeling, no significant radioactivity readings were obtained from the isolations.
12. Gross determinations of $C^{14}$ activity were made with a G-M monitor having sensitivity of $10^{-3}$ to $10^{-4}$ μc. Where specified, they are given as counts per minute above background and are considered significant.


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## Waxy Constituents of the Saw Palmetto, *Serenoa repens* (Bartr.) Small


**Edward A. Wilder and Eugene D. Kitzke**

***Basic Research Department,***
***S. C. Johnson & Son, Inc., Racine, Wisconsin***


*Serenoa repens* (Bartr.) Small (*1*), commonly called the saw palmetto and often incorrectly called the scrub palmetto, is the most abundant palm in the United States. It occurs in wide distribution in the southeastern and southern states, ranging from South Carolina to the Florida Keys and along the Gulf Coast to Louisiana (Fig. 1).

Although considered somewhat of a weed because it is so ubiquitous, it was found useful in industrial application during World War II when it yielded an accepted cork substitute that could be processed from the soft tissue of the stem (*2*). Other potential uses include tannin source (*3*), fibers, wallboard, and paper.

Because the world market can always appreciate a new hard vegetable wax to supplement existing commercial waxes, such as carnauba (*Copernicia cerifera*), candelilla (*Euphorbia antisyphilitica*), ouricuri (*Syagrus coronata*), sugar-cane wax (*Saccharum officinarum*), and others, recent attention was given to the saw palmetto as a source of wax. In previous field observations, we had noted the waxy bloom.

The leaves used in this study were collected in southern Florida. They were sun-dried, using the technique commonly practiced by harvesters of carnauba in Brazil. The wax was removed from the leaves by brushing off the free-flaking wax first and then by solvent, extracting the entire leaf with heptane to determine total extractables. The free-flaked wax was essentially the same in character as the solvent-extracted wax. The characteristics of the sample of wax examined are as follows:

Fig. 1. Saw palmetto undergrowth in a slash pine (*Pinus caribaea* Morelet) woods. This is a common ecological pattern.

| | |
|---|---|
| Acid number | 16.3 |
| Saponification number | 101.5 |
| Melting point | 81.2°C |
| Iodine number | 9.8 |
| Needle penetration, 100 g/5 sec | $< 1$ |

The wax is hard, brown in color, and somewhat resinous in appearance. Considering its qualities for possible use in naphtha-type polish products, it has a precipitation temperature of 98°C, which unfortunately is unusually low for a hard vegetable wax. A gel formation that occurs in naphtha containing 18 percent solids is firm, although it is grainy and has poor solvent retention. The wax contains about 13 percent of resinous material, of which 6.5 percent is soft and tacky and can be removed by leaching the powdered wax with cold (25°C) acetone, and 6.5 percent is hard resinous material that is insoluble in boiling isopropanol. Although this 13 percent of resinous material is lower than what one finds in candelilla wax (20 percent) the near absence of resinous material in carnauba is a better criterion of a good vegetable wax.

The leaf sizes, when compared with carnauba, were found to be relatively small, having a dry weight ranging from 35 to 58 g, which is considerably smaller than the 150-g average for the Brazilian palm. In a group of selected leaves, the free-flaking yields ranged from 1.44 to 2.7 g of wax based on 100 g of leaf. Solvent stripping of these leaves indicated an average total wax yield of 5.81 g/100 g of leaf. The average yield for all leaves on the basis of total solvent extractables was about 4.9 g/100 g of leaf, a surprisingly high yield, almost equivalent to carnauba. However, carnauba wax is nearly totally free-flaking, while the palmetto is only partly so. The only present commercial processes for harvesting wax from this type of palm leaf utilize mechanical methods requiring a free-flaking leaf. The yields by solvent stripping may be of little practical interest at present.

Although this wax could represent a new valuable raw material for some wax-consuming industries, the polish manufacturers would most likely find it of less value than the principal hard vegetable waxes now on the market.

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## Relationship of Adrenalin to Tissue Sulfhydryl Compounds


**U. D. Register and R. G. Bartlett, Jr.**

*Departments of Biochemistry and Physiology, College of Medical Evangelists, Loma Linda, California*


Such treatments as restraint (*1*), exposure to cold (*2*), and exposure to cold and restraint (*3*) have been shown to cause a lowering of the total nonprotein sulfhydryl concentration (TSH) of the liver. Since these several physiological stresses cause a drop in liver TSH, the possibility exists that the stresses elicit a general response which is the more immediate cause of the changes in the concentration of the sulfhydryl compounds. It is known that the sympatho-adrenal mechanism is activated by such stresses as these. To test the possibility of such a mechanism, rats were injected with adrenalin, and the effect on tissue TSH was compared with saline-injected controls (*4, 5*).

Healthy adult female Sprague-Dawley rats were used. The 60 animals were divided into two groups—30 control animals injected with isotonic saline and 30 animals injected with adrenalin. A 1 : 10,000 solution of adrenalin hydrochloride was injected subcutaneously—1.0 ml initially and 0.5 ml each half-hour over a period of 4½ hr. The control animals were similarly injected with isotonic saline. All the animals were stunned with a blow on the head; blood was obtained by cardiac puncture, and the tissues were excised immediately and frozen with dry ice. Ergothioneine (ESH) was determined by a modified method of Hunter (*6*), and TSH was determined by amperometric titration, using a modification of the method of Benesch and Benesch (*7*).

As is shown in Table 1, subcutaneous injections of adrenalin produced no significant change in the ESH of the blood or the liver or in the TSH of the blood or muscle. However, there was a significant drop in the TSH of the liver and the kidney. The fall in TSH in each of these organs were approximately 35 percent of the control value. It should be noted that, since there was no change in liver ESH, changes in glutathione (GSH) levels must largely account for the changes observed in TSH. These results add credibility to the hypothesis that sympathetic stimulation with adrenal medullary activation is the active agent in the lowering of the concentrations of these compounds in the afore-mentioned general physiological stresses.

The data showing no change in muscle TSH with adrenalin injection are in agreement with the work of Ilín (*8, 9*), who used cats and measured GSH rather than TSH. Zunz and Vesselousky (*10*) obtained an increase in blood GSH concentration after intravenous injections of adrenalin in cats. However, in the present study, no measurable change in erythro-

Table 1. The effect of injection of adrenalin on tissue nonprotein sulfhydryl compounds.

| Organ | Sulfhydryl analyzed | Sulfhydryl (μM %) | |
|---|---|---|---|
| | | Controls (saline injected) | Adrenalin injected |
| Whole blood* | TSH† | 107 ± 4.4‡ (8)§ | 112 ± 4.4 (8) |
| | ESH‖ | 31 ± 1.6 (8) | 34 ± 2.3 (7) |
| Liver | TSH | 799 ± 10.3 (30) | 506 ± 8.5 (30) |
| | ESH | 63 ± 1.3 (10) | 62 ± 2.1 (10) |
| Kidney | TSH | 444 ± 19.7 (10) | 280 ± 11.1 (10) |
| Muscle | TSH | 106 ± 5.1 (10) | 101 ± 3.1 (10) |

* No significant difference in hematocrits; average, 43.9 percent.
† Total nonprotein sulfhydryl.
‡ Standard error of the mean.
§ The number in parentheses represents the number of animals in each group.
‖ Ergothioneine.

cyte GSH was observed with subcutaneous injections of adrenalin in rats.

The fact that the concentration of these compounds in the liver and the kidney is readily altered by adrenalin, which stimulates the increased metabolism of carbohydrates, suggests the labile role that sulfhydryl groups may play in intermediary metabolism. Several investigators have already shown that GSH is essential in reactions involving the metabolism of glycogen to form energy (*11, 12*). Since a rapid mobilization of glycogen from the liver occurs upon the application of a general physiological stress (which releases adrenalin) or upon the administration of adrenalin, it appears that the diminution in sulfhydryl groups under these conditions may be due partially to their utilization in glycogen breakdown.

Note added in proof: Because the notation TSH may be confused with the thyroid-stimulating hormone, it might well be replaced by NPSH.


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8 February 1954.


## Action of $T_2r^+$ Bacteriophage on Host-Cell Membranes


**Leonard F. Barrington* and Lloyd M. Kozloff**

*Department of Biochemistry, University of Chicago*


Weidel has shown in studies with bacterial membrane preparations that the interaction of intact $T_2r^+$ bacteriophage with the host-cell membranes results in a disintegration of the membranes (*1*). However, there has been no quantitative information concerning the liberation of nonsedimentable material from the host (cell membranes).

*Escherichia coli*, strain B, was grown with aeration to a concentration of $1.4 \times 10^9$ cells per milliliter on a synthetic glucose-salt medium, with 7.7 atom percent excess $N^{15}$ $(NH_4)^+$ as the nitrogen source. From this culture, a cell-membrane suspension was prepared and isolated according to the procedure of Weidel. The preparation was free of viable cells and moved as a single boundary in both the ultracentrifuge and the electrophoresis apparatus, as indicated by Weidel, but differed somewhat from his preparation. The sedimentation constant, 2300 $S$, differed from his value of 6500 $S$; the electrophoretic mobility was $-7 \times 10^{-5}$ $cm^2/v$ sec at $p$H 6.72, $\Gamma/2 = 0.2$, while Weidel reported a value of $-10 \times 10^{-5}$ $cm^2/v$ sec at $p$H 7.0, $\Gamma/2 = 0.1$; the elemental analysis showed an N/P ratio of 10, compared with his reported ratio of N/P of 11.

Table 1. Results of $T_2r^+$—*E. coli* B membrane interaction.

| Expt. | $T_2r^+$ infective units introduced per membrane | $T_2r^+$ units adsorbed per membrane | Percentage of membrane N-nonsedimentable* | Percentage of $T_2r^+$ N-nonsedimentable† | Membrane N made nonsedimentable per $T_2r^+$ adsorbed ($10^{-15}$ mg) |
|---|---|---|---|---|---|
| 1 | 2.5 | 2.48 | 4.2 | 17.3 | 101 |
| 2 | 2.5 | 2.48 | 3.3 | 38.2 | 87 |
| 3‡ | 2.5 | 1.40 | 1.3 | 15.7 | 61 |
| 4 | 5.0 | 4.95 | 7.7 | 19.1 | 98 |
| 5 | 11.25 | 11.0 | 15.0 | 34.7 | 86 |
| 6§ | 187.5 | 185.5 | 73.8 | 13.0 | 29 |

* Based on $N^{15}$ determinations and corrected for small amount of nonsedimentable N in original membrane suspension.

† $T_2r^+$ N by difference, based on total N and $N^{15}$ determinations.

‡ System contained $9 \times 10^{-3} M$ $Ca^{++}$.

§ System contained $6 \times 10^{-4} M$ $Ca^{++}$.

Ninety-nine percent of both added $T_2r^+$ and added $T_6r^+$ were adsorbed by these membranes as determined by plaque count of free phage before and after incubation with the membranes. In the study of the release of nonsedimentable N, only $T_2r^+$ bacteriophage was used.

Unlabeled $T_2r^+$ bacteriophage and the bacterial membranes were incubated at 37°C for 150 min in an isotonic phosphate buffer, $p$H 7.0 ($\Gamma/2 = 0.16$). Samples were withdrawn for assay of free phage by plaque count, and the incubation samples were centrifuged for 2 hr in the cold at 18,000 $g$. Such conditions of centrifugation are capable of completely sedimenting the original virus particles and the membranes. The final supernatants were assayed for total nitrogen and for $N^{15}$.

Analyses of the samples indicated that membrane nitrogen is converted into a nonsedimentable form by virus-membrane interaction in amounts proportional to the ratio of virus particles to membranes.

Earlier findings, with intact bacterial cells, have shown that virus material is also made nonsedimentable by interaction with bacteriophage (*2–4*). Hershey


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and Chase have observed that adsorption of $T_2$ to bacterial membranes results in liberation of the phage DNA in a nonsedimentable form (*5*). In the present studies, emphasis is placed on the release of nonsedimentable nitrogen from the host-cell membranes, but release of nonsedimentable virus nitrogen is also shown. Representative experimental values are given in Table 1.

Electron micrographs taken at zero time and after incubation showed that adsorption of $T_2r^+$ was accompanied by disintegration of the virus and the conversion of the membrane to a granular residue.

The chemical nature of the substances "solubilized" from the membranes and the application of the foregoing findings to studies with intact host cells are presently being investigated.

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## The Effect of Pasteurization on the Stability of Phosphates Can Be Used as a Test for Heated Milk


**Socrates A. Kaloyereas**

*Department of Agricultural Chemistry and Biochemistry, Louisiana State University, Baton Rouge*


It has been known for a long time that heating of milk results in a lowering of its *pH* (*1*). However, neither the explanation given for its cause by Whittier and Benton (*2*), who attribute it to the lactic acid formed from lactose, nor the earlier idea expressed by Orla-jensen and Plattner (*3*), attributing it to the formation of lactic acid from casein, seems justified in light of the results reported here. It was found that heating of milk at 62°C for 30 min, in order to pasteurize it, results in a decrease of its *p*H, whereas more prolonged heating does not have any further effect on the *p*H (Table 1).

These results indicate that a stable equilibrium is reached during the early period of heating and, as will be explained, the reaction that takes place stops when one of the reactants, namely, the carbonic acid, is unavailable. Titration curves of the rennet serums from raw and pasteurized milk show two characteristic differences at the points ending the titration of monocalcium phosphate and dicalcium phosphate. The $dB/dp$H values of milk serum changed by pasteurization from 0.0146 to 0.0159 at the range of the titration of monocalcium phosphate and from 0.0059 to 0.0052 at the range of the titration of dicalcium phosphate. These differences indicate an increase of monocalcium phosphate and a more or less proportionate

Table 1. Effect of heating on the *p*H of milk.

| Sample | Raw (*p*H) | Pasteurized at 62°C: For 30 min (*p*H) | Pasteurized at 62°C: For 60 min (*p*H) |
|---|---|---|---|
| 1 | 6.75 | 6.71 | 6.71 |
| 2 | 6.77 | 6.69 | 6.69 |
| 3 | 6.70 | 6.62 | 6.62 |
| 4 | 6.73 | 6.65 | 6.65 |
| 5 | 6.68 | 6.63 | 6.64 |
| 6 | 6.81 | 6.78 | 6.78 |
| 7 | 6.78 | 6.73 | 6.73 |
| 8 | 6.63 | 6.57 | 6.57 |
| 9 | 6.65 | 6.60 | 6.61 |
| 10 | 6.64 | 6.58 | 6.58 |

decrease of dicalcium phosphate in pasteurized milk serum. The new equilibrium established between monocalcium phosphate and dicalcium phosphate in the heated milk serums is a result of a reaction that, most probably, takes place between dicalcium phosphate and carbonic acid as follows:

$$2CaHPO_4 + H_2CO_3 \rightarrow Ca(H_2PO_4)_2 + CaCO_3.$$

Serum from heated milk exhibits a characteristic increase in stability, especially at *p*H 4.6, when heated at 70°C as compared with the serum of raw milk. This increased stability is shown not only by the increased heating time required to bring about the precipitation of phosphates but also by the smaller amount of the precipitate formed. Furthermore, the increased turbidity found in the supernatant liquid of the precipitated heated-milk serum indicates the greater stability of the phosphates there and provides further evidence of the reaction that takes place during pasteurization. It was found that the greater cause of turbidity of the supernantant liquid is the presence of carbonates and that by eliminating them—according to the Curtman and Hart method (*4*)—the tur-

Table 2. Average values for moist precipitates turbidity of supernatant liquids and stability (time needed for flocculation) of serum at *p*H 4.6 when heated at 70°C in a constant-temperature water bath.

| Milk serum | Moist precipitate | Stability (min) | Turbidity optical density | Decrease of turbidity after elimination of carbonates (%) |
|---|---|---|---|---|
| Raw | 2.6 | 15–20 | 0.300 | 84 |
| Pasteurized | 1.0 | 20–25 | .900 | 60 |
| Powdered milk | | | | |
| Pet | 0.4 | More than 30 | .290 | |
| Starlac | .1 | No flocculation | .400 | |

bidity assumes very low values in both heated- and raw-milk serums (Table 2).

Additional evidence of the validity of this theory of the cause of the decrease in the *p*H of milk by pasteurization was obtained from experiments with artificial mixtures of monocalcium and dicalcium phosphates. A mixture of these two salts, at about the same concentration in which they occur in milk (*5*), was prepared, and its *p*H was adjusted to a value approaching that of milk by adding small amounts of carbonate solution. When this mixture was heated at the pasteurization temperature of milk, its *p*H decreased, and generally the mixture behaved like milk in this respect. These facts indicate definitely that the decrease in the *p*H of milk effected by the pasteurization treatment is due to the new equilibrium established between monocalcium phosphate and dicalcium phosphate through a reaction that takes place between dicalcium phosphate and carbonic acid.

The work of Muller and Knöffel (*6*) has shown that carbonic acid at higher temperatures reacts to a certain extent with secondary and tertiary calcium phosphates with the production of primary calcium phosphate. This can also be deduced from the result obtained by Windish and Dietrich quoted by Mellor (*7*).

We have found that the lowering of the *p*H of milk effected by heat treatment and the resulting increased stability of the phosphates of the serum can be used as a test for differentiating heated milk from raw milk in their mixtures. Details of this work, as well as other possibilities now being explored, for using the change of the stability of phosphates in other biological fluids, will be reported later elsewhere.


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19 February 1954.

# Communications

## Effect of X-irradiation on the Adrenal Cortical Steroid Excretion in Urine

Abundant indirect evidence (*1–4*) supports the prevalent idea that adrenal cortical activity is altered following the stress of x-irradiation. The following preliminary results of the determination of the adrenal cortical steroids in the urine of pigs after lethal x-irradiation give more direct evidence (*5*).

Two castrated, male Chester-White pigs each weighing approximately 22 lb were given 1000 and 750 r, respectively, of total body x-irradiation. The factors were 1000 kv, 3.0 ma, Pb parabolic, 35-in. target-skin distance, and output 8.9 and 9.25 r/min, respectively.

Table 1. Total neutral adrenal cortical steroids in urine of pigs given lethal total body x-irradiation.

| Day | Pig No. 1, 1000 r, mg/24 hr | Pig No. 2, 750 r, mg/24 hr |
|---|---|---|
| −2 | | 1.1 |
| −1 | 0.9 | 0.7 |
| 0 | .9 | .5 |
| 1+* | 1.7 | 2.4 |
| 2+ | 1.4 | 0.7 |
| 3+ | 0.4 | 1.1 |
| 4+ | .3 | 1.8 |
| 5+ | Animal expired | 0.8 |
| 6+ | | 1.0 |
| 7+ | | Animal expired |

* Irradiated on this day; 24-hr urine collection was begun immediately following irradiation.

Control and post-irradiation 24-hr urine collections were obtained. The urine was stored at 5°C without preservatives. The total neutral $C_{21}$ adrenal steroids were determined by the method of Burton, Keutmann, and Waterhouse (*6*) with the modification that they were quantitated by the method of Mader and Buck (*7*).

Table 1 shows the marked increase in the urinary excretion of adrenal cortical steroids in these animals after lethal total body x-irradiation. It is to be noted that the increase was most marked in the first 24-hr period following exposure of the animals to the radiation.

The data are conclusive only in that they supply direct evidence of acutely altered adrenal cortical activity following lethal total body x-irradiation.


F. T. Brayer
S. R. Glasser
B. J. Duffy, Jr.
*Medical Division, Department of Radiation Biology, University of Rochester School of Medicine and Dentistry, Rochester, New York*



**References and Notes**

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20 April 1954.

## Pleuropneumonia-like Organisms Isolated from Bronchopneumonia of Cattle

A bronchopneumonia of varying severity is invariably associated with a disease of cattle referred to as shipping or transit fever (*1*). The disease appears frequently in cattle transported over long distances by ship or rail. That it is a distinct infectious disease is suggested by the constancy of its pathological (*2*) and clinical (*3*) manifestations and the ease with which it is spread to unpredisposed contact cattle.

Bacteriological examinations were conducted on 24 calves ranging in age from 4 to 12 mo, all of which had a severe bronchopneumonia either directly or indirectly related to shipment by rail. The principal bacterial species isolated from the lungs were *Pasteurella hemolytica, P. multocida,* and *Corynebacterium pyogenes*. Details of the bacteriological and pathological findings will be presented in a later report.

With a view to examining for the presence of organisms of the pleuropneumonia group, inocula from the lungs were streaked on "Bacto-PPLO agar" (+1 percent "Bacto-PPLO serum fraction") and "Bacto-tryptose agar" (+20 percent horse serum). On these mediums microscopic colonies were frequently demonstrated in primary cultures, employing the methylene blue-azure stain described by Dienes (*4*). However, in all but two instances subcultures were not successful and it was thought that perhaps the mediums were inadequate. This contention was strengthened by the demonstration in secondary broth cultures of forms that Freundt (*5*) has associated with loss of viability.

With an improved medium, essentially the same as that described by Edward (*6*), two additional isolations were made and maintained through indefinite subcultures without difficulty. On this medium the strains isolated on the PPLO and tryptose agar grew more rapidly and produced larger colonies. The four strains successfully propagated were similar in regard to colonial morphology and all fulfilled Sabin's (*7*) criterions for admission to the pleuropneumonia group of organisms. Characteristic colonies are shown in Fig. 1.

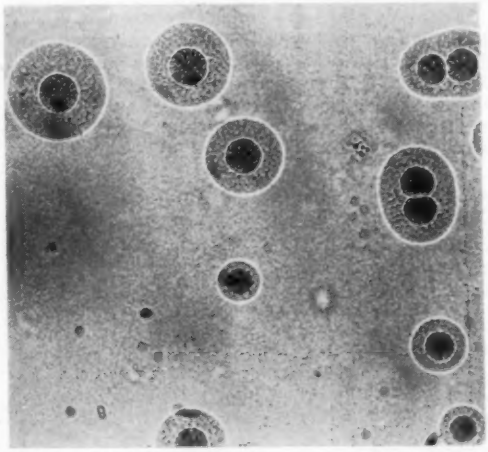

**Fig. 1.** Colonies of the pleuropneumonia-like organism from bronchopneumonia of cattle (×120).

That the pleuropneumonia-like organisms isolated are parasitic is suggested by the difficulty experienced in their isolation and propagation. Their recovery from bronchopneumonic lungs of cattle is important if only because of their resemblance to the organism that causes the serious epizootic of cattle, contagious pleuropneumonia.

G. R. Carter

*Department of Bacteriology,*
*Ontario Veterinary College, Guelph, Canada*

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26 April 1954.

## The Heparin-like Activity of Certain Inorganic Anions

Phosphotungstate, phosphomolybdate, and silicotungstate have been found to delay the clotting of blood, both *in vitro* and *in vivo*. When injected into rats, they also elicit the appearance in the plasma of lipemia "clearing factor" (*1*), an enzyme that catalyzes the lipolysis of chylomicrons and low-density lipoproteins. This clearing factor appears to be identical with that produced by heparin injection. Both anticoagulant activity and clearing-factor production occur following oral administration of silicotungstate.

The test animals were male Sprague-Dawley rats weighing about 180 g. The usual intravenous dose was 20 mg dissolved in 1 ml of 0.15*M* sodium chloride solution; it was injected either as the acid or as the sodium salt. The usual oral dose of silicotungstate was 200 mg of the salt in 1 ml of water administered by stomach tube in the fasting state. The heparinoid activities were apparent a few minutes after intravenous injection and 20 min after oral administration (Table 1). Lee-White clotting times were prolonged two- to fivefold. Clearing activity was measured by the decrease in optical density of a saline suspension of human chylomicrons incubated at 38°C with 1/10 rat plasma by volume during a period of 1 hr.

The anticogulant activity was inhibited by protamine, both *in vitro* and *in vivo*. Clearing activity was inhibited by protamine and by high sodium chloride concentrations (*2*). During clearing, glycerol was produced. All three salts exhibited metachromatic activity with toluidine blue. In all these respects they resemble heparin.

These findings make it appear likely that the hepar-

Table 1. Clotting time and clearing activity in rats following inorganic salts.

| Drug | Dose (mg) | Route | Clotting time (min) Before prot. | Clotting time (min) After prot.* | Clearing activity (o.d. units) Before prot. | Clearing activity (o.d. units) After prot.* | |
|---|---|---|---|---|---|---|---|
| None | | | < 4 | | < 0.015 | | |
| Sodium phosphotungstate | 20 | i.v. | 9 | 2 | .11 | 0.02 | |
| | 20 | i.v. | 13 | 3 | .09 | .02 | |
| | 20 | i.v. | | | .09 | plasma pre-incubated for 2 hr in | 0.15*M* NaCl |
| | | | | | .03 | | 0.76*M* NaCl |
| | | | | | .01 | | 1.37*M* NaCl |
| Sodium silicotungstate | 200 | oral | 6 | | .07 | | |
| | 200 | oral | 10 | | .07 | | |

* Immediately after first bleeding, rat received 3 mg protamine and was bled again 3 min later.

inoid activity of a serum mucoprotein precipitated with phosphotungstic acid, as reported by Greenspan (*3*), is an artifact. Samples of phosphotungstate-precipitated mucoprotein prepared by us from bovine serum according to his method contained appreciable amounts of ash. Qualitative analysis indicated the presence of tungsten in these preparations.

The number of substances having heparin-like activity is thus extended to include inorganic compounds. These compounds resemble heparin and other heparinoids in having a relatively high molecular weight and negative charge but differ from them in the absence of carbohydrate and sulfur. Detailed data and additional studies will be reported elsewhere.

JOSEPH H. BRAGDON
RICHARD J. HAVEL
*National Heart Institute, Bethesda 14, Maryland*

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28 April 1954.

## Rapid Separation of Diamond from Other Forms of Carbon

A rapid method for the separation of diamond from other materials, especially other forms of carbon, was desired. It was also desired that the method be quantitative—that is, no loss of diamond.

A number of preliminary experiments were made with various acids, salts, oxidants, and fluxes, but the most effective method found was preferential oxidation with catalyzed perchloric acid.

Approximately 0.1-g samples of the materials listed in the following paragraph were used. Samples were treated as follows: (i) fumed to dryness with red nitric acid; (ii) oxidized with 10 to 20 ml of 60-percent perchloric acid; catalyzed with approximately 0.1-g of ammonium metavanadate at 200°C (generally 30 min); (iii) diluted with water and the insoluble vanadium oxides reduced with an excess of hydroxylamine hydrochloride; (iv) washed, centrifuged, dried, and weighed any diamond residue.

The following materials were treated by the aforedescribed method: (i) carbon blacks—Thermax, Shaw, P33, Dag 154, Spheron 6, and Spheron 9; (ii) graphites—Dixon 200-09 and UCC grade SP2 spectrographic in the form of rods, chunks, and 60-mesh powder; (iii) diamond—0.1 g (approximately) macles and 4000-mesh dust. Materials under (i) and (ii) were completely oxidized in approximately 30 min in most cases. However, some coarse graphites took several hours. Oxidation without catalyst took approximately 10 times longer. Diamond was not attacked in 5 to 6 hr as judged by weighing (± 0.1 mg) and optical examination.

Perchloric acid has been used by others to remove graphite from diamond (*1*). Catalysts have been used with perchloric acid as an oxidant for carbonaceous materials (*2*). Thus the method outlined is an application of these methods. It has been found to be the most convenient and effective method of those investigated.

F. S. PHINNEY
*Crystal Branch, Solid State Division,*
*Naval Research Laboratory, Washington, D.C.*

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18 February 1954.

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*18.* Stanford Conf. on Population Problems of Latin America, Stanford, Calif. (R. Hilton, Hispanic American Studies, Stanford Univ., Stanford.)

*19–20.* National Council of Geography Teachers, San Francisco, Calif. (Mrs. I. C. Robertson, State Teachers College, Valley City, N.D.)

*19–31.* International Conf. of Ship Hydrodynamics, 7th, Göteborg, Sweden. (H. F. Nordstrom, Statens Skeppsprovningsanstalt, Göteborg.)

*20–26.* American Pharmaceutical Assoc., Boston, Mass. (R. P. Fischelis, 2215 Constitution Ave. NW, Washington 7, D.C.)

*23–26.* American Veterinary Medical Assoc., annual, Seattle, Wash. (J. G. Hardenberg, 600 S. Michigan Ave., Chicago 5, Ill.)

*23–28.* International Cong. for the Philosophy of Science, 2nd, Zurich, Switzerland. (Sec., Internationales Forum Zurich, Room 20d, Eidengenssische Hochschule, Zurich 6.)

*23–28.* International Cong. of Soil Science, 5th, Leopoldville, Belgian Congo. (F. A. van Baren, Royal Tropical Inst., Mauritskade 63, Amsterdam, Netherlands.)

*23–28.* International Photobiological Cong., Amsterdam, Netherlands. (Cong. Soc., Radiologische Laboratorium, Wilhelminagasthuis, Amsterdam.)

*23–3.* International Scientific Radio Union, 11th, The Hague, Netherlands. (I. E. Herbays, 42 Rue des Minimes, Brussels, Belgium.)

*24–28.* Potato Assoc. of America, Estes Park, Colo. (R. L. Hougas, Dept. of Genetics, Univ. of Wisconsin, Madison.)

*25–27.* American Phytopathological Soc., annual, Estes Park, Colo. (G. S. Pound, Dept. of Plant Pathology, Univ. of Wisconsin, Madison.)

*25–27.* Biological Photographic Assoc., 24th annual, Atlantic City, N.J. (A. F. Hancock, Photo Unit, Jefferson Hospital, 1020 Sansom St., Philadelphia 7.)

*25–27.* Western Electronics Show and Convention, Los Angeles, Calif. (M. Mobley, Jr., 344 N. LaBrea Ave., Los Angeles 36.)

*27–28.* Minnesota Acad. of Science, Itasca State Park, Minn. (B. O. Krogstad, Dept. of Biology, St. Olaf College, Northfield, Minn.)

*28–29.* Soc. for Social Responsibility in Science, annual, Yellow Springs, Ohio. (SSRS Office, Gambier, Ohio.)

*30–1.* American Soybean Assoc., 34th annual, Memphis, Tenn. (G. M. Strayer, ASA office, Hudson, Iowa.)

*30–31.* Mathematical Assoc. of America, 35th summer, Laramie, Wyo. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

*30–3.* International Soc. of Orthopedic Surgery and Traumatology, 6th, Bern, Switzerland. (M. Dubois, Isle-Hospital, Bern.)

*30–3.* International Symposium on Combustion, 5th, Pittsburgh, Pa. (B. Lewis, Alcoa Bldg., Pittsburgh 19.)

*30–9.* International Mathematical Cong., Amsterdam and The Hague, Netherlands. (M. H. Stone, Dept. of Mathematics, Univ. of Chicago, Chicago 37, Ill.)

*31–5.* American Mathematical Soc., summer, Laramie, Wyo. (E. G. Begle, AMS, Yale Univ., New Haven, Conn.)

*31–10.* UN World Population Conf., Rome, Italy. (J. D. Durand, Room 3025B, UN Bldg., New York.)

## *Meetings & Conferences*

**August, *contd.***

*31–10.* World Population Cong., Rome, Italy. (F. Lorimer, American Univ., Washington 16, D.C.)

**September**

*1–7.* International Soc. for Cell Biology, 8th, Leiden, Netherlands. (W. H. K. Karstans, Botanical Laboratory, State University, Nonnensteig 3, Leiden.)

*1–8.* British Assoc. for the Advancement of Science, annual, Oxford, England. (Sec., BAAS, Burlington House, London, W.1.)

*1–8.* International Cytological Cong., Leiden, Netherlands. (P. G. Gaillard, Histologisch Laboratorium, Rijksuniversiteit, Leiden.)

*1–11* International Committee of Electrochemical Thermodynamics and Kinetics, 6th annual, Paris and Poitiers, France. (P. Van Rysselberghe, Dept. of Chemistry, Univ. of Oregon, Eugene.)

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*2–9.* International Cong. of Mathematicians, annual, Amsterdam, Netherlands. (Sec., 2d Boerhaavestraat 49, Amsterdam.)

*3–7.* International Symposium on Infrared, Parma, Italy. (S. S. Ballard, The Rand Corp., Santa Monica, Calif.)

*3–8.* American Psychological Assoc., annual, New York City. (F. H. Sanford, 1333 16 St., NW, Washington 6, D.C.)

*3–8.* Psychometric Soc., annual, New York City. (J. B. Carroll, Harvard Univ., 13 Kirkland St., Cambridge 38, Mass.)

*5–9.* American Inst. of Biological Sciences, Gainesville, Fla. (F. L. Campbell, 2101 Constitution Ave., Washington, D.C.)

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## *Meetings & Conferences*

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*5–9.* Ecological Soc. of America, Gainesville, Fla. (J. F. Reed, Dept. of Botany, Univ. of Wyoming, Laramie.)

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*5–9.* Sigma Delta Epsilon, Gainesville, Fla. (M. Gojdics, Barat College, Lake Forest, Ill.)

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*7.* Phycological Soc. of America, Gainesville, Fla. (R. H. Thompson, Dept. of Botany, Univ. of Kansas, Lawrence.)

*7–10.* Alaska Science Conf., 5th, Anchorage, Alaska. (AAAS, Box 960, Anchorage.)

*8–9.* Soc. of General Physiologists, annual, Woods Hole, Mass. (J. B. Buck, National Institutes of Health, Bethesda 14, Md.)

*8–10.* American Physiological Soc., Madison, Wis. (W. B. Youmans, Dept. of Physiology, Univ. of Wisconsin, Madison.)

*8–10.* American Soc. of Mechanical Engineers, fall, Milwaukee, Wis. (O. B. Schier, II, 29 W. 39 St., New York 18.)

*8–10.* American Sociological Soc., Urbana, Ill. (J. W. Riley, Jr., A.S. Soc., New York Univ., New York 3.)

*9–11.* American Political Science Assoc., annual, Chicago, Ill. (J. Gange, 1785 Massachusetts Ave., NW, Washington 6, D.C.)

*9–17.* International Cong. of Ophthalmology, 17th, Montreal, Canada, and New York, N.Y. (W. L. Benedict, 100 First Avenue Bldg., Rochester, Minn.)

*10–12.* Gerontological Soc., Gainesville, Fla. (A. J. Carlson, Univ. of Chicago, Chicago 37.)

*10–13.* Econometric Soc., Montreal, Canada. (R. L. Cardwell, Cowles Commission, Univ. of Chicago, Chicago 37.)

## *Meetings & Conferences*

**September, *contd.***

*10–13.* Inst. of Mathematical Statistics, American Statistical Assoc., and Econometric Soc., Montreal, Canada. (K. J. Arnold, Dept. of Mathematics, Michigan State College, East Lansing.)

*10–16.* International Symposium on Problems in Contemporary Optics, Florence, Italy. (S. S. Ballard, The Rand Corp., Santa Monica, Calif.)

*10–24.* American Soc. of Photogrammetry, Philadelphia, Pa. (C. E. Palmer, 1000 11 St., NW, Washington 1, D.C.)

*12–16.* American Inst. of Chemical Engineers, Glenwood Springs, Colo. (C. H. Prien, Research Inst., Univ. of Denver, Denver 10, Colo.)

*12–16.* Illuminating Engineering Soc., Atlantic City, N.J. (A. D. Hinckley, 1860 Broadway, New York 23.)

*12–17.* American Chemical Soc., annual, New York City. (R. M. Warren, 1155 16 St., NW, Washington 6, D.C.)

*12–17.* International Assoc. for the Prevention of Blindness, New York City. (Prof. Franceschetti, 3 Ave. Miremont, Geneva, Switzerland.)

*13–17.* International Cong. of Cardiology, Washington, D.C. (L. W. Gorham, American Heart Assoc., 44 E. 23 St., New York 10.)

*12–17.* International Organization Against Trachoma, Montreal, Can. (A. Sorsby, 45 Lincoln's Inn Field, London W.C.2.)

*13–14.* American Microscopical Soc., annual, Philadelphia, Pa. (C. J. D. Brown, Dept. of Zoology and Entomology, Montana State College, Bozeman.)

*13–15.* Analytical Instrument Clinic, 3rd annual, Philadelphia, Pa. (A. H. Peterson, 4400 5 Ave., Pittsburgh 13, Pa.)

*13–17.* Assoc. of Applied Biologists, 50th anniversary, London, Eng. (R. K. S. Wood, Imperial College of Science and Technology, London, S.W.7.)

*13–18.* International Cong. of Nutrition, 3rd, Amsterdam, Netherlands. (M. van Eekelen, 61 Catharynesingel, Utrecht, Netherlands.)

*13–19.* International Cong. on Industrial Medicine, 11th, Naples, Italy. (Sec. of Cong., Istituto Medicine del Lavoro, Universita, Policlinico, Piazza Miraglia, Naples.)

*13–19.* International Soc. of Blood Transfusion, 5th, Paris, France. (Col. Julliard, 57 Boulevard d'Auteuil, Boulogne sur Seine, France.)

*13–20.* International Soc. of the History of Medicine, 14th, Rome and Salerno, Italy. (M. Galeazzi, Citta Universitaria, Rome.)

*13–25.* International Instrument Cong. and Exposition, 1st, Philadelphia, Pa. (R. Rimbach, 921 Ridge Ave., Pittsburgh 12, Pa.)

*14–29.* International Union of Geodesy and Geophysics, Rome, Italy. (W. E. Smith, 1530 P St., NW, Washington 5, D.C.)

*15.* International Cong. of Industrial Chemistry, 27th, Brussels, Belgium. (Mr. Guilmot, 32 Rue Joseph II, Brussels.)

*15–17.* American Assoc. of Clinical Chemists, 6th annual, New York City. (M. M. Friedman, Lebanon Hospital, New York 57.)

*15–18.* International Cong. of Internal Medicine, 3rd, Stockholm, Sweden. (A. Kristenson, Karolinska Sjukhuset, Stockholm 60.)

# *Meetings & Conferences*

**September, *contd.***

*17–18.* Calorimetry Conf., 9th annual, Schenectady, N.Y. (W. De Sorbo, GE Research Laboratories, Schenectady.)

*21–23.* Soc. for Experimental Stress Analysis, Philadelphia. (W. M. Murray, Central Square Station, P.O. Box 168, Cambridge 39, Mass.)

*21–24.* American Roentgen Ray Soc., Washington, D.C. (B. R. Young, Germantown Hospital, Philadelphia 44, Pa.)

*22–24.* Conf. on the Protection of Plants in Hot Climates, Marseilles, France. (P. Bonnet, Palais de la Bourse, Marseilles.)

*22–24.* Mississippi Valley Medical Soc., 18th annual, Chicago, Ill. (H. Swanberg, 209–224 W.C.U. Bldg., Quincy, Ill.)

*22–28.* International Symposium on High-Speed Photography and Kinematography, 2nd, Paris, France. (P. Naslin, Laboratoire Central de l'Armement, Fort de Montrouge, Arcueil, France.)

*23–28.* European Cong. and Clinical Chemistry, 1st, Amsterdam, Netherlands. (Ir. O. Meulemans, Racinelaan 17, Utrecht, Netherlands.)

*24.* American Medical Writers Assoc. 11th annual, Chicago, Ill. (H. Swanberg, Drawer 110, Quincy, Ill.)

*24–25.* International Symposium on Problems in Physiology and Pathology of the Eye, Iowa City, Iowa. (F. C. Blodi, Dept. of Ophthalmology, State Univ. of Iowa, Iowa City.)

*26.* Cong. of International Soc. of Medical Hydrology, Vichy and Paris, France. (G. Ammirandoli, Via Della Torretta 11, Montecatini Terme, Italy.)

*26–2.* International Union Against Tuberculosis, 13th, Madrid, Spain. (J. Aliz, Calle Francisco Silvela 20, Madrid.)

*26–2.* World Medical Assoc., 8th general assembly, Rome, Italy. (L. H. Bauer, 345 E. 46 St., New York 17.)

*27–2.* Interantional Conf. on Engineering Education, 2nd, Switzerland. (L. A. Rose, Univ. of Illinois, Urbana.)

*27–2.* Symposium on Macromolecular Chemistry, Turin and Milan, Italy. (A. Nasini, Corso Massimo d'Azeglio 48, Turin.)

**October**

*1–5.* International Cong. of Chronometry, Paris. (R. Baillaud, Observatoire National, Besançon, France.)

*2–6.* International Cong. on Diseases of the Chest 3rd, Barcelona. (American College of Chest Physicians, 112 E. Chestnut St., Chicago 2.)

*3–5.* Southern Psychiatric Assoc., Louisville, Ky. (G. Southerland, 2218 N. Charles St., Baltimore.)

*3–7.* Electrochemical Soc., autumn, Boston. (H. B. Linford, Columbia Univeristy, New York 27.)

*4–6.* National Electronic Cong., 10th annual, Chicago. (K. Kramer, 852 E. 83 St., Chicago 19.)

*4–7.* International Plastics Cong., 6th, Turin, Italy. (M. Muzzoli, Salone Internazionale della Tecnica, 20 Via Massena, Turin.)

*4–13.* International Telecommunication Union, 17th, Geneva, Switzerland. (Sec., ITU, Palais Wilson, Geneva.)

*5–7.* American Inst. of Electrical Engineers, Middle Eastern District, Reading, Pa. (H. H. Henline, 33 W. 39 St., New York 18.)

*5–8.* International Cong. of Hydatid Diseases, 5th, Madrid. (J. C. Melendro, Hospital Provincial, Sorea, Spain.)

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